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SOMATIC RESPONSE MECHANISMS IN PSYCHONEUROSIS

ROBERT B. MALMO, CHARLES SHAGASS, AND JOHN F. DAVIS

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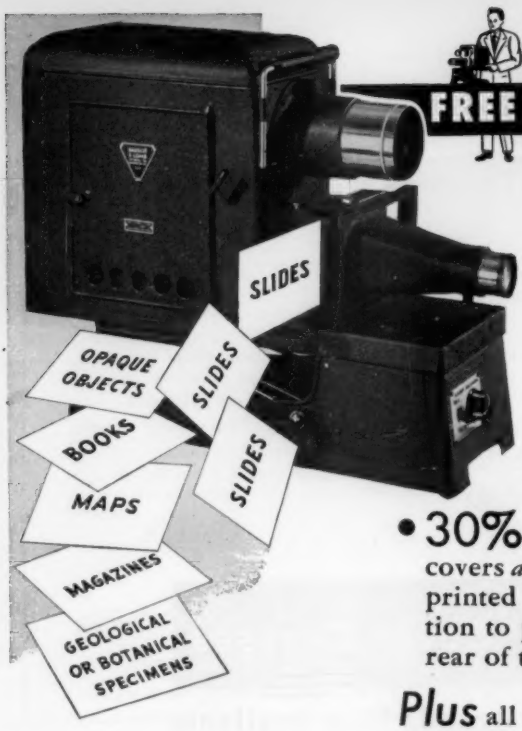

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A Method for the Investigation of Somatic Response Mechanisms in Psychoneurosis[1]

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Allan Memorial Institute of Psychiatry, McGill University, Montreal, Quebec

THE PSYCHONEUROSES are characterized by states, such as anxiety, which appear to be emotional responses of pathologically increased intensity and duration. Little is known concerning the neural processes that underlie these disorders of emotional experience in psychoneurosis, although recent investigations have indicated that they are accompanied by abnormally increased excitability in both the autonomic and the central nervous systems (*8*). This paper is concerned with the development of a method that could be used for experimental investigation of basic central nervous system processes involved in psychoneurosis.

Largely in response to the influence of Cannon and his school (*1*), physiological studies of emotion have centered upon the increased activity in the sympathetic division of the autonomic nervous system, for example, increased heart rate and blood pressure. That increased parasympathetic excitation may also occur during strong emotion, however, is clearly indicated by such phenomena as involuntary evacuation of the bowel and fainting. Further, although seldom the subject of experimental investigation, the important role of the central nervous system in states of emotional excitement has long been recognized from clinical observations of hyperreflexia; and the electromyographic studies of Jacobson (*3*) have provided objective evidence of increased muscular tension in emotional disturbance. Consequently, any concept that attempts to integrate the facts concerning the physiology of emotion must take into account the events occurring in all main divisions of the nervous system.

The most widely accepted integrating principles concerning the physiological aspects of emotion are Cannon's concepts of emergency reaction and homeostasis. From the standpoint of these concepts some emotions are viewed as states of preparation for fight or flight; and the autonomic changes that accompany these emotions have been interpreted as events designed to ensure appropriate bodily conditions during such activity as, for example, greater blood flow to the muscles provided by increased blood pressure. The attention directed toward the homeostatic role of the autonomic nervous system in emotions has unfortunately led to neglect of the part played by the central nervous system. Muscular tension changes in emotion cannot be fully understood in terms of increased supportive function by the autonomic nervous system. The somatic motor system is characterized by shorter latencies of reaction than the autonomic system. In some emotion-producing situations skeletal muscle tension may complete a cycle of rise and return to prestimulation level, well before autonomic homeostatic mechanisms have had time enough to complete their cycles. This makes it appear necessary to seek a homeostatic mechanism with direct control over *somatic* (skeletal) motor activities by the *central* nervous system.

Recent discoveries in the physiology of brain-stem, thalamic, and cortical interrelationships have resulted in the description of the thalamic and brain-stem reticular systems, which may provide the necessary mechanisms for "somatic" homeostasis (*4, 7, 9*). Jasper (*4*) has found that stimulation of the thalamic reticular system effectively eliminates cortical afterdischarge resulting from sensory stimulation, and muscular afterdischarge produced by direct stimulation of the motor cortex. Moruzzi and Magoun (*9*) have shown that stimulation of the brain-stem reticular system will produce similar effects. From this recent work Jasper has concluded as follows:

> It seems, therefore, that there exists a separate regulatory system involving thalamic and other brain stem structures which acts upon the cortex, controlling the form and rhythm of the background of cortical activity upon which afferent impulses must act, and regulating local and generalized excitatory states of the cortex as a whole (*4*, p. 418).

The reticular system thus seems to exert a regulatory (homeostatic) effect upon cortical and motor activity. Since pathological anxiety appears to involve an excess of excitation in the somatic motor

[1] This research was performed under Contract No. W-49-007-MD-422 between the Department of the U. S. Army, Office of the Surgeon General, and McGill University.

[2] The authors wish to acknowledge gratefully the invaluable suggestions of H. H. Jasper, of the Montreal Neurological Institute, and the assistance of F. H. Davis and E. J. Martin.

mechanisms (*8*), it is conceivable that this could be due to defective regulatory action (inhibitory) of some somatic homeostatic mechanism, such as the thalamic or brain-stem reticular system.

The method described in this paper was designed to bring experimental data to bear upon the question of defective somatic regulatory action in pathological anxiety. The following features were sought in devising the method: (1) The physical characteristics of external stimulation should be subject to exact measurement and control. (2) Stimuli should be of nonpainful intensity so that avoidance movements would not be produced. (3) In order to simulate the simple conditions of neurophysiological stimulation experiments, no voluntary reaction to stimulation should be required. (4) Recordings should be made from the somatic motor system with an apparatus capable of following the rapid changes in this system and of providing exact measurements of activity. (5) Given all of these features, the method, to be useful for studies of pathological anxiety, must distinguish clearly between the physiological activity of patients with pathological anxiety, and that of normal subjects.

The purpose of the present preliminary study was to test the differentiative capacity of a method that satisfies the first four criteria. If the method were shown to discriminate effectively between psychoneurotics and normals, it would be useful as a basic tool for further investigations of somatic response mechanisms in psychoneurosis.

As a technique that appeared likely to satisfy the criteria outlined above, we selected a procedure similar to the one used by Davis (*2*) in his studies of electromyographic response to strong auditory stimuli. Davis showed, with normal subjects, that auditory stimulation produces measurable electromyographic responses, even when subjects are instructed not to respond to the stimulus.

The subjects were 10 psychiatric patients, 5 of each sex, and 10 controls drawn from the medical and secretarial staffs of the hospital and matched with the patients for age and sex. The patients were all psychoneurotics in whom severe pathological anxiety was a prominent symptom. In one case of severe anxiety there were also symptoms suggesting early schizophrenia.

During the experiment the subject lay on a hospital bed. Action potentials from the extensor muscles of the right forearm were recorded by one channel of an Offner (Type D) EEG from silver leads, one placed over the extensor crest and the other at the wrist. The right forearm was placed in the prone position, and the subject was instructed to hold a rubber bulb in the right hand and to maintain a constant pressure on it throughout the experiment. Apart from this, he was asked to relax as much as possible. Davis (*2*) showed that induced tension increases the electromyographic response to sound. (In preliminary experiments we found that the induced tension provided by the rubber bulb was necessary for responses of sufficient magnitude to be easily recorded by our equipment.)

The auditory stimulus was a 1,000-cycle tone of 3 seconds' duration which was kept at an electrically constant intensity. This intensity was approximately 80 decibels above threshold, as determined by having 8 subjects compare the tone with an audiometer standard. Stimuli were 90 seconds apart, and there were 10 stimuli during the test proper. These were transmitted to the subject through binaural earphones. It should be mentioned that a constant feature of the stimulus was a sharp "on-effect," which gave the impression of a click of very brief duration.

The subject was instructed that he would hear a tone in the earphones. He was asked to disregard this tone and to make no response of any kind. Reassurance regarding the experimental situation was given as needed before and during the test. In a trial period before the test proper, 3 stimuli of increasing intensity were administered, the last one being of the same intensity as that used in the test. The subject was told that the last tone was what he would hear from then on, and that no louder tones would come.

Analysis of the electromyographic tracings was carried out by a method similar to that of Davis. The time periods chosen for measurement were as follows: (*a*) 1 second preceding the stimulus; (*b*) the 3-second stimulus period; (*c*) the 1-second period 12–13 seconds after the start of stimulation. These periods were divided off into fifths of seconds. For each fifth second the largest muscle potential spike was selected. This spike was measured in millimeters, and the millimeter measurements were converted to microvolts by reference to d-c calibrations.[3] This phase of the analysis required 5,000 individual measurements.

In statistical treatment of the data for each subject the 10 stimuli were averaged for each fifth second, and the mean amplitude of the muscle spikes determined. For group averages the medians of these means were calculated, because means would have been unduly influenced by the extremely high potentials of 2 subjects in the patient group. The chi-square test

[3] The largest spike in a given time period was selected for measurement in order to reduce the number of measurements required and to facilitate the actual measuring. The assumption was that total potential would parallel the largest spike. Frequency or spike duration was not measured because of methodological difficulties, and because previous studies with present recording methods have shown spike amplitude alone to be an adequate indicator of degree of muscular activity.

was used for determination of statistical reliability.

Median amplitude curves for the patient and control groups are shown in Fig. 1. The median prestimulus tension level of the patient group (24.5 μv) was somewhat higher than that of the controls (15.9 μv); however, this difference was not statistically reliable. In the first 0.2 second after onset of the stimulus, both patient and control groups showed approximately equal rise in tension. In the next fifth of a second (0.2–0.4 second), the control subjects' tension fell to approximately prestimulus level, whereas the potentials of the patients continued to rise, so that their response to stimulation was now double that in the first 0.2 second. For the remainder of the stimulus period, EMG amplitude for the controls showed steady tension at about prestimulus level, with only a slight increase in tension at about the 1-second mark (probably the "b-response" of Davis). On the other hand, the patients' curve, after reaching peak amplitude from 0.2 to 0.4 second after start of stimulation, began to descend relatively slowly, and with numerous oscillations. At the end of the 3-second stimulus period, it was still well above the prestimulus level. The measurements for the period, 12–13 seconds after onset of stimulation, revealed that complete recovery had taken place, and both patients and controls were at about their prestimulus tension levels.

The data shown in Fig. 1 reveal a major difference

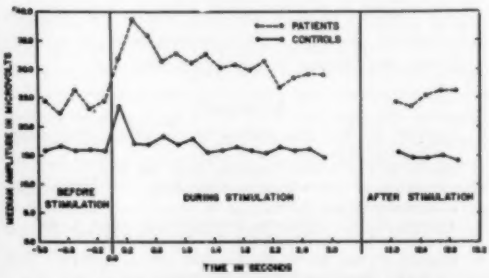

FIG. 1. Comparison of patients and controls with respect to median EMG amplitudes before, during, and after stimulation. Interval of measurement = 0.2 second.

in the response characteristic of the patients and controls. The initial tensional response (0–0.2 second) was equal in both groups, but, whereas the controls then returned to pre-existing tension levels, the patients showed further augmentation of response, and their response was prolonged over the entire period of auditory stimulation. Since the major qualitative and quantitative difference between the groups seemed to be evident particularly in the first second of stimulation, a more detailed analysis of this time period was carried out. The electromyograms for the half-second preceding stimulus onset and the first second of stimulation were remeasured for tenth-second intervals. These data for tenths of seconds were then averaged in the same way as those for fifths.

Fig. 2 shows response curves for patients and con-

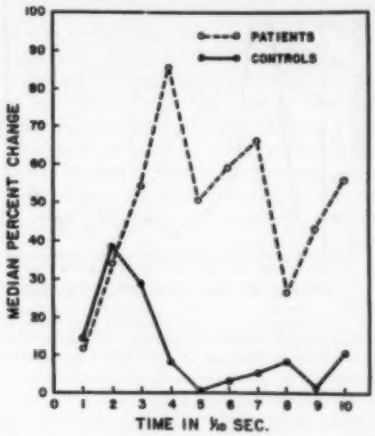

FIG. 2. Percent change in EMG response during first second of stimulation. Interval of measurement = 0.1 second.

trols during the first second of stimulation. The curves are plotted in terms of median percent change from the average level preceding the stimulus. Percentages were used to avoid the possible influence of prestimulus tension differences on size of response. Fig. 2 shows clearly the identical electromyographic response (change) of patients and controls during the first 0.2 second of stimulation. From 0.2 to 0.3 second the control curve falls, and that of the patients continues to rise, reaching a peak at a time when the controls are almost back to prestimulus level.

The significant difference between patients and controls was shown in two ways: (1) Although immediate electromyographic response (change) upon stimulation was approximately the same in both patient and control groups, after the first 0.2 second of stimulation the change was decidedly greater in the patients. (2) The peak response of the patients occurred much later than the peak response of the controls. The statistical reliability of these differences was determined as follows: (*a*) The median response of the entire subject group for the period from 0.2 to 0.6 second was determined; 8 of the 10 patients showed responses greater than the median, and 8 of the 10 controls showed responses less than the median. The difference was reliable at the 1 percent level of confidence. (*b*) The tenth of a second during which the peak potential was reached during the first second of each stimulus was determined for each subject and for the group. Fig. 3 shows how

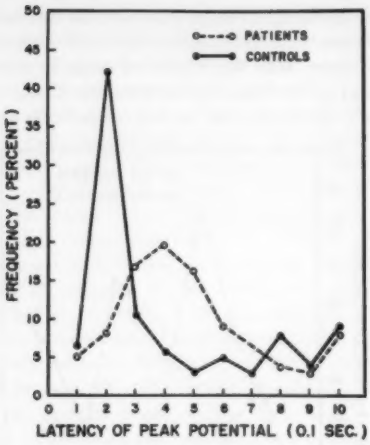

FIG. 3. Distribution curves showing that peak EMG responses in patients occurred most frequently after the normal latency for arm in the startle pattern (approximately 0.2 second).

often peaks were observed during each tenth-second interval in the patient and control groups. Whereas in the control group 50 percent of the peaks were found in the first 0.2 second, the patients showed only 13 percent of their peaks during this time. Moreover, the patients had 63 percent of their peaks from 0.2 to 0.6 second, whereas the controls had only 25 percent of their peaks during this period. These differences were highly reliable statistically. Individual comparisons between matched patients and controls also yielded a highly reliable difference with respect to the frequency with which peak responses occurred during the first 0.2 second of stimulation.

Onset of tonal stimulation at high intensity and the click ("on-effect") appeared to constitute an effective startle stimulus for the subjects. According to Landis and Hunt (*6*, p. 30) the latencies for the arm in the startle pattern range from 125 to 195 milliseconds. It was during this interval in our experiment that percent of change was approximately equal for patients and controls. This also agrees quite well with Davis' finding of what he calls the "a-response" (and which he relates to startle) with a peak at 0.2 second. It seems reasonable to assume, therefore, that the immediate startle reaction was approximately the same in patients and controls. The difference between the groups appeared *after* the 0.2-second period of reflex startle.

These results are what might have been expected from the hypothesis that, in anxiety, inhibition of cortical afterdischarge, through some regulatory mechanism, such as the reticular system (thalamic and/or brain-stem) is defective. The term afterdischarge is used on the assumption that *normally* the initial impact of click and tone has higher stimulating value (startle) than the continuation of the tone for the remainder of the 3-second stimulation interval. This assumption is based on our present finding with normal control subjects.

These positive findings make it seem worth while to proceed to a more detailed analysis of somatic response mechanisms in psychoneurosis. Kubie (*5*) has previously emphasized the importance of the factor of somatic overexcitation in anxiety. He has integrated observations from the clinical field, from Pavlovian conditioning, and from the work of Landis and Hunt on the startle pattern; and he has identified anxiety with the anticipation of explosive "irradiation" of excitation.

Present considerations suggest that the principal source of somatic overreaction in pathological states of anxiety may be defective somatic regulation by such a mechanism as the thalamocortical elaborative system. The present technique, modified according to the particular purpose of each separate experiment, appears a promising one for further investigations of somatic response mechanisms in psychoneurosis.

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Technical Papers

Penetration of Trypsin through Formvar Films

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An orthodox explanation has been advanced recently (*4*) for Rothen's effect (*1*), i.e., the interaction between antigen and antibody through a blanket of inert material like Formvar. Phosphate ions from the buffer that was used were shown to be responsible for a migration of antigen (bovine serum albumin) through the Formvar blanket. The antigen was then able to react with antibody molecules at the blanket surface by direct contact. Those experiments, however, did not account for Rothen's (*2*) finding that enzymes (trypsin, pepsin) are also able to act upon substrate layers through an intervening screen. The medium in his experiments for trypsin was veronal buffer, and the substrate was bovine serum albumin. We have shown (*4*) that bovine serum albumin penetrates Formvar blankets in the presence of phosphate buffer but that it does not do so when veronal buffer, physiological saline, or distilled water is used.

To avoid introducing an explanation of the enzyme behavior by means of unknown forces, let us assume in this case that the enzyme (and not the substrate) is able to penetrate the screen under the exact conditions of Rothen's experiment, bearing in mind that his control experiment with a floating screen does not duplicate precisely the conditions of his original experiment. In this control he used a thin Formvar film floating on veronal buffer and showed that no trypsin activity could be found in this buffer after he placed a droplet of trypsin solution on top of the floating screen and allowed it to remain for some time.

On this assumption we have performed experiments using the same basic type of procedure as in Rothen's and our former work. The results indicate that the concept of long-range forces is not needed to explain enzyme-substrate reactions with intervening inert screens. Active trypsin molecules can penetrate Formvar screens; the amount of penetration is a function of the screen thickness (Figs. 1, 2). Under the conditions of these experiments, the original distance between enzyme and substrate is of the order of 10^6 A, which is well beyond the range of even the most imaginative estimates for long-range forces.

It is true that this experiment does not repeat exactly the conditions of Rothen's original one. He used a trypsin solution, and we used trypsin deposited as an S-layer underneath a screen. We find that trypsin molecules are still active under these conditions. The important consideration is the similarity of the physical state of the screen, as our former experiments and also Singer's (*3*) work have shown. Our new work has the advantage over Rothen's control experiment in that we deposit the screen on a solid surface, as in his original experiment. It might well be that important changes take place when a Formvar screen is transferred from a water surface to a slide. Cracks, or the strain caused by spreading the screen over a slightly irregular surface, or even the influence of the adsorptive forces of the underlying surface, may be responsible for the protein permeability.

The fact is, however, that with veronal buffer the trypsin and not the albumin migrates through the screen. The mechanisms involved are complex. Much more work must be done before we can hope for a better understanding of these reactions of molecular layers, which have been brought into the focus of general attention by Rothen's stimulating work.

In one experiment 5 chromium-coated microscopic slides (*A–E*) and 2 cover-glass slips (*S*) were assembled as shown in Fig. 1 (cross section parallel to the shorter edge

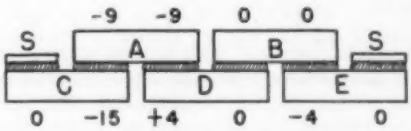

FIG. 1. Action of veronal buffer.

of slides). Plates *A* and *B* lie face down. Plates *C*, *D*, and *E* lie face up. Previous to the experiment proper, all 5 plates were coated simultaneously with an optical base of 39 layers of barium stearate, plus 4 additional steps of 1 double layer each. Then all 5 plates were conditioned in veronal-buffered uranyl acetate solution. Plates *A* and *B* were then dipped for 10 min into a solution of crystallized trypsin (Armour) containing 1 mg trypsin/cc in veronal buffer, 0.067 *M*, pH 7.5. A layer of trypsin molecules about 25 A thick was thus adsorbed from solution. Both plates were then rinsed once with veronal buffer and twice with distilled water. This treatment does not remove the adsorbed layer of trypsin molecules. Plate *A* was then coated with 2 Formvar layers (total thickness, 45 A), and plate *B* with 4 Formvar layers (total thickness, 90 A). Plates *C* and *E* were coated simultaneously with 3 double layers of spread crystallized bovine serum albumin (total thickness, 57 A); and on top of that 1 layer of Formvar (22 A) was placed. Plate *D* was not treated any further and acted as control and pickup. After these preparations and after measurement of each plate on 4 boundary lines, the 5 plates and the 2 cover slips were assembled as shown in

Fig. 1, with 0.05 ml veronal buffer between opposite parts and with enough free horizontal space between adjacent plates to prevent interference. The thickness of the liquid barrier was in all instances about 0.1 mm.

This pile was left for 10 min in a wet chamber. The plates were taken apart rapidly and carefully washed with distilled water and measured after drying. The figures inserted in the diagram indicate the respective loss or gain in A on each treated part. The experiment shows clearly that plate *A* lost material equally on both locations, that plate *C* lost material only on the part opposite the trypsin plate *A*, and that plate *D* adsorbed some material on the part opposite plate *A*. On the other hand, plate *B*, which had the thicker Formvar screen, did not lose a measurable amount of material, and the part of plate *D* opposite *B* is also unchanged. On that part of plate *E*, however, which was opposite plate *B* there is a slight loss of material. There was no change on the two parts of plates *C* and *E* over which cover glasses had been placed. The only plausible explanation for these results is this: Trypsin molecules were able to pass through the thinner Formvar screen on plate *A* and diffused through the buffer solution toward plates *C* and *D*. On plate *C* they penetrated the single Formvar screen and split part of the substrate underneath, which in turn diffused through the screen back into the solution and was removed by washing. On plate *D*, however, the trypsin has been adsorbed. On the other hand, the thicker Formvar screen on plate *B* prevented diffusion of trypsin almost completely, so that no adsorption could be detected on the control plate *D*; but the slight loss on plate *E* indicates that the 4 layers of Formvar still permitted some trypsin molecules to reach the substrate layers on this plate. The cover-slip controls on plates *C* and *E* show that the veronal buffer itself does not remove substrate from underneath the screen. This experiment has been performed several times with essentially the same results.

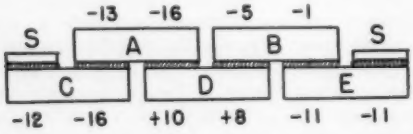

FIG. 2. Action of phosphate buffer.

If the same experiment is done with distilled water instead of veronal buffer, we do not find changes on any of the plates exceeding 2 A–3 A. The standard deviation for different boundary lines was between ± 0.5 A and ± 1.5 A in this set of experiments.

In another experiment, an identical set of plates, as described in Fig. 1, was used. The thickness of adsorbed trypsin on plates *A* and *B* was 28 A. The Formvar film on plate *A* was 46 A thick (2 layers) and on plate *B*, 75 A thick (4 layers). The 3 bovine serum albumin double layers on plates *C* and *E* were 48 A, and the single Formvar layers on top, 16 A in thickness, respectively.

Phosphate buffer was used instead of veronal buffer. After a 10-min period in the wet chamber the plates were rinsed once with veronal buffer and twice with distilled water.

As can be seen from Fig. 2, there is a combined effect of the phosphate buffer on the substrate, as well as on the enzyme. The leaching action on the bovine serum albumin of phosphate buffer through Formvar films, which has been reported previously (*4*), is demonstrated here again. But, furthermore, we find that trypsin is removed through a Formvar film by phosphate buffer. The phosphate action is even stronger than the veronal action, as a comparison of Fig. 1 and Fig. 2 shows.

The difference in loss on plates *C* and *E* can be explained by a double action of trypsin activity and phosphate leaching on plate *C*. The interesting fact that the 2 trypsin plate parts that are opposite plate *D* show a larger loss than the 2 parts opposite the substrate plates (*C* and *E*) can be explained by assuming that the substrate is removed relatively rapidly through the thin Formvar film on plates *C* and *E* and is adsorbed to a certain extent on the opposite parts of plates *A* and *B*. Either this adsorbate interferes somewhat with the diffusion of the trypsin, or it is still present after washing the plate at the end of the experiment. Also, a combination of these two effects seems to be possible and would account for the observed differences.

A detailed discussion of these experiments will be published elsewhere.

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On the Interaction of Protein Films

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In view of two recent notes by H. J. Trurnit (*4, 5*) on the interaction of protein films, it seems appropriate to state clearly the point of view held in this laboratory.

In previous publications (*1, 2*), we have shown that thin blankets of barium stearate or of plastic material, coating antigenic layers deposited on metallic slides, do not prevent a specific adsorption of homologous antibodies and, further, that certain enzymes, which would inactivate the adsorbed substrate layers, are capable of inactivating them also in spite of intervening blankets.

In the first of the above-mentioned notes, Trurnit concluded that the observed interaction between antigen and antibody through a blanket can be explained by a simple diffusion process of the antigenic layers. This explanation was based on the fact that the ions of a phosphate buffer are capable of leaching out, through a relatively thin Formvar blanket, a fair amount of bovine albumin

adsorbed as multilayers. Singer (*3*) also had previously concluded that the observed interaction resulted from a simple diffusion process of either the antibody or the antigen or both.

In the second note, appearing on page 329 of this issue, Trurnit postulates that the inactivation by trypsin of adsorbed layers of bovine albumin results from the diffusion of the trypsin molecules through the blanket.

The fundamental point involved is to decide whether a long-range interaction does take place in the observed phenomena. If it can be shown that under the experimental conditions a simple diffusion process is inadequate to explain all the facts now available, *then a long-range action of some kind must be assumed.* Whether the interacting entities eventually come into closer proximity is a secondary issue, if ordinary diffusion forces are insufficient to bring about the closer proximity.

There is a wealth of experimental evidence that seems to be definitely against the simple diffusion of antigenic layers, antibody, or enzyme molecules through a blanket. For instance, a specific adsorption of homologous antibody is still observed to occur through at least 100 A of barium stearate or Formvar when the antiserum is diluted in veronal instead of phosphate buffer. Veronal buffer has no leaching effect whatever by itself. The thickness of antibody that can be adsorbed by slides coated with 1, 2, or 3 double layers of bovine albumin amounts to about 40 A per double layer after a 3-min adsorption period, and is independent of pretreatment of the slides by the veronal buffer alone. The leaching effect by phosphate buffer, which was observed independently by Trurnit, does not occur when 1 double layer of bovine albumin is deposited on the slides; nevertheless, specific adsorption can take place between the double layer of bovine albumin and antibody despite intervening blankets.

Multilayers of bovine albumin can be partially inactivated, as far as their reaction with homologous antibody is concerned, by bombardment with α-particles. A system of 6 such monolayers partially inactivated can still adsorb a layer 80 A thick of homologous antibodies. However, a blanket of Formvar 80 A thick deposited on the layers before or after irradiation prevents any adsorption of antibody, whereas the same blanket would permit considerable specific adsorption if the layers had not been bombarded. These experiments demonstrate that these antibody molecules definitely do not go through by simple diffusion.

The minimum thickness of a blanket necessary to prevent the inactivation of bovine albumin layers by trypsin is a function of the number and the mode of deposition of the layers. The greater the number of layers, the thicker must be the blanket. A Formvar blanket 20 A thick is sufficient to prevent the inactivation by trypsin of 1 deposited monolayer of bovine albumin, whereas more than 600 A of Formvar is necessary when there are 6 underlying monolayers of bovine albumin. Moreover, deposited multilayers of bovine albumin are partially inactivated by heating at 105° C for 10 min. Six "up" layers after such a heat treatment adsorb specifically a layer 100 A thick of antibody, instead of the usual 180 A. Trypsin directly applied on the heated antigenic layers destroys their immunological property just as fast as if they had not been heated, but a blanket of Formvar 130 A thick protects them completely from trypsin. Such a thickness of Formvar would permit complete inactivation of nonheated layers. Finally, the pH of the water upon which the monolayers are formed before transfer on the slide has a considerable effect on the thickness of the blanket necessary to protect them against trypsin. Five monolayers transferred from an "old" water can be inactivated through a screen of Formvar 400 A thick, whereas, if the water has been freshly redistilled, a Formvar blanket of 200 A protects them completely.

In all these cases the "physical state" of the blanket is the same, and, therefore, in none of them can one assume that trypsin goes through by simple diffusion. Trurnit's contention that his control experiments are better than ours is erroneous, because he fails to take into consideration the series of experiments just mentioned.

All these facts clearly show that it is unjustified to envisage the permeability of a blanket as such, either to antigenic layers or trypsin molecules. As we said two years ago (*2*), "If the enzyme molecules do actually diffuse through the blanket, they must then diffuse faster or slower depending on the mode of deposition and number of the antigenic layers underneath, a process which in itself would involve a long-range action." The comparison of a blanket to a sieve with definite-size holes is a misconception; the passage of a molecule of a certain size depends not only on the size of the holes but on the intensity of the fields of force acting through the screen on the molecule.

Finally, the evidence brought forward by Trurnit in his second note, that trypsin molecules go through the blanket by a simple diffusion process, is unconvincing for the following reasons. At no time did Trurnit test his antigenic films with homologous antibody to find out whether the films had lost their immunological property. He is satisfied to consider a small decrease in the thickness of his deposited layers as an indication of trypsin action. Our experience of many years has shown us that, quite often, a small decrease in the apparent total thickness of antigenic layers can occur without being accompanied by a corresponding loss in the amount of antibody that can be subsequently adsorbed; in other words, without loss of immunological reactivity. Consequently, we must regard the few observations offered by Trurnit as insufficient evidence in favor of simple diffusion being the explanation of our observations.

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The Cytological Effects of Low-Intensity Radiation[1]

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The effects of low intensities of ionizing radiation are of interest in relation to the incidence and nature of induced mutations. The effects of long-continued radiation at low intensities are also of interest from the standpoint of atomic energy programs in times of peace or war. Little is known about the cumulative effects of exposure over long periods of time.

The early work by Muller and by Timofeeff-Ressovsky showed a linear relationship between x-ray dosage and mutation frequency in *Drosophila*. It was also found that the induced mutation rate was independent of radiation intensity. From these observations it was concluded that the x-ray-induced mutations are produced by single "hits," and that there is no threshold effect. Spencer and Stern (*2*) found no increase over the spontaneous mutation rate by irradiating *Drosophila* for 21 days at 2.5 r/day, but later experiments by Uphoff and Stern (*3*) indicated that low intensities are effective.

Further studies on x-ray-induced mutations by Stadler showed that such "mutations" are usually, if not always, caused by aberrations of the chromosomes. The aberrations usually involve deficiencies, but inversions and translocations may also produce "mutations." The frequency of simple deletions is directly related to x-ray dosage, but the aberrations involving two breaks—rings, dicentrics, translocations, and presumably inversions—increase in frequency in proportion to the square of the dosage when the time of exposure is constant.

At very low intensities of irradiation, the simple deletions constitute the great majority of all chromosome aberrations in *Tradescantia*. A total dose of 150 r of γ rays at an intensity of 0.05 r/min produced 5% of deletions, but only 0.6% of translocations and dicentrics in Tradescantia chromosomes. The same dose of x-rays at an intensity of 40 r/min produced essentially the same percentage of simple deletions, but 10% of rings and dicentrics.

Although low intensities of ionizing radiation are less effective, the accumulation of aberrations and lethal "point mutations" over a long period of time could be just as deleterious as smaller doses given at high intensities. The effects of long-continued exposure of low-intensity radiation have been studied by exposing potted plants of *Tradescantia paludosa* (Clone 3) to low intensities of γ radiation for several months. The results are shown in Table 1.

The control plants show considerable variability in spontaneous chromosome aberrations. The average percentage of chromosome breaks for the total of all controls was .08%. If, however, plants removed from the radium beam for 4 weeks or longer are included among the controls, the spontaneous aberration frequency is reduced to .06% of breaks.

TABLE 1

CHROMOSOME ABERRATIONS AND POLLEN STERILITY INDUCED BY 1.7 R/DAY OF γ RADIATION

Weeks of exposure	Controls		Irradiated	
	No. chromosomes	% breaks	No. chromosomes	% breaks
1	2,052	.10	7,380	.06
2	1,480	.07	5,010	.18
3	2,190	.14	5,460	.57
4	2,280	.09	5,820	.53
6	2,166	.09	4,830	.33
11	4,350	.07	2,322	.52
22	6,180	.05	3,300	.52
Total	20,698	.08 (av.)	21,732*	.49 (av.)

* Total for 3–22 weeks.

Continued exposure to 1.7 r of γ rays/day increased the aberration frequency at the end of the second week, and a continued increase at the end of 3 weeks' exposure. There was, however, no further increase in aberration frequency following continued exposure. At the end of 22 weeks the plants had received 262 r of γ radiation, but showed only 0.5% of breaks in the microspore chromosomes. This dose of x-rays, given in a few minutes at the prophase stage, would have produced more than 30% of breaks.

The increase in aberration frequency during the first few weeks of exposure is due to the accumulation of aberrations produced during microspore development. During the fall and winter months, when this study was made, the duration of the microspore cycle from meiosis to the division of the microspore nucleus is about 12 days. Aberrations produced at late meiosis may be passed on to a viable microspore, but most detectable aberrations produced at the first meiotic division or earlier are not recovered at the microspore nucleus division, because of lethal deficiencies that prevent microspore development.

The failure of a cumulative effect of the γ radiation could be attributed to the screening-out of chromosome aberrations at meiosis and/or to differential development of normal and aberrant cells in premeiotic development. These alternatives were tested by a study of pollen sterility and by a chromosome analysis of plants removed from the field of radiation. Plants that had received 1.7 r/day for 2 months were removed from the beam, and microspore chromosomes were examined during subsequent weeks. The data are shown in Table 2. There was some decrease in chromosome aberrations after a week, and after the third week the chromosome aberration frequency was reduced to the spontaneous level. If the lack of this cumulative effect is due only to the screening of chromosome aberrations at meiosis, the pollen sterility should increase with continued exposure, and eventually the plants should be completely sterile. Pollen sterility counts were made at weekly intervals from plants exposed to 1.7 and 8.0 r/day for 12 weeks.

[1] This work was supported by the Office of Naval Research, Contract number N.R. 164,823. Henry Luippold, technician.

TABLE 2

FREQUENCY OF CHROMOSOMAL ABERRATIONS AFTER REMOVING PLANTS FROM 2 MONTHS' EXPOSURE TO 1.7 r OF γ RADIATION. RECOVERY PERIODS, 1 WEEK TO 4 MONTHS

Recovery time	No. chromosomes	Chromatid breaks	Chromosome breaks	Total % breaks
1 week	3,150	7	3	.32
2 weeks	4,320	4	0	.09
3 "	5,760	4	4	.14
4 "	2,910	1	0	.03
6 "	1,800	0	0	.00
4 months	6,180	3	0	.05

Counts from control plants were made at the same time. The normal sterility varies considerably, presumably in response to environmental conditions of temperature and light, and ranged from 5 to 14%. The percentage of sterility in the controls was deducted from the sterility of the exposed plants to give the net sterility due to radiation effects. The data are shown in Table 3.

TABLE 3

POLLEN STERILITY INDUCED BY CONTINUOUS RADIATION AND THE RECOVERY OF POLLEN FERTILITY SUBSEQUENT TO 5 WEEKS OF EXPOSURE

No. weeks exposure	Net pollen sterility			
	During exposure		After exposure	
	1.7 r/day	8 r/day	1.7 r/day	8 r/day
1	6	−1	28	42
2	11	4	28	42
3	29	3	18	48
4	37	14	18	56
5	24	35	4	37
6	35	37	3	33
7	31	50		50
8	42	53		53
9	25	48		18
10	27	43		9
11	21	55		9
12				2
13				0

At an intensity of 1.7 r/day the pollen sterility increased during the first 3 weeks and then leveled off at about 30%, although there was considerable variability from week to week. At 8 r/day the maximum sterility was not reached until about the sixth or seventh week, presumably in consequence of the retarding effect of the greater amount of radiation; but after 6 weeks' exposure, the pollen sterility remained at about 50% during the subsequent weeks. At this intensity there was considerable inhibition of floral development, and very few flowers were produced after 2 months of exposure.

After 5 weeks of exposure some of the plants were removed from the field of radiation in order to see how long the pollen sterility would continue. At 1.7 r/day the pollen fertility at 5 weeks after exposure was practically normal. At 8 r/day the plants did not recover normal fertility until about 12 weeks after removing them from the beam of γ rays. This greater delay in recovery is attributed to the greater retardation of growth of the plants at the higher intensity.

The lack of a cumulative effect in the production of microspore chromosome aberrations and pollen fertility after several weeks' exposure to low intensities of γ rays, and the recovery of normal microspore chromosomes and pollen fertility after the plants are removed from the radiation field, indicate that cells containing chromosome aberrations do not continue to divide or are outgrown by the normal cells. Earlier work (*1*) has shown that, if sufficient radiation is given to produce chromosomal aberrations in nearly all cells, the plant dies. At low intensities of radiation many cells are not permanently affected, and presumably these cells are the ones that produce the normal microspore chromosome complements and the fertile pollen grains. Continuous exposure to several roentgens per day does not seriously reduce pollen fertility or seed set, although it is possible that some deleterious mutations may appear in later generations. The fact that both chromosome aberrations and pollen sterility level off after a few weeks of exposure indicates that the plants can survive and reproduce after months, or perhaps even years, of exposure.

These results indicate that Tradescantia plants, and probably most plants, can survive continuous radiation at the rate of several roentgens per day. Unfortunately, they cannot be expected to apply to the higher animals, including man. The factors of determinate growth, high sensitivity of critical tissues, the absence of haploid mitosis in gametophytic development, and the lack of rapid somatic divisions preceding egg formation, should render animals much more vulnerable to low intensities of ionizing radiation.

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A Comparison of the Response of Normal and Hypothyroid Mice to Acute Whole Body Roentgen Radiation[1]

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In 1949 Blount and Smith (*1*) showed that premedication with thiouracil slightly decreased the mortality of mice subjected to acute whole body roentgen ray irradiation. This would indicate that the hypothyroid state was conducive to survival after roentgen ray irradiation. Shortly thereafter Patt *et al.* (*6*) reported significant decreases in radiation mortality in animals premedicated with cysteine. It was postulated that the beneficial effect

[1] This paper is based on work performed under Contract AT-04-1-GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

observed was the result of protection of the sulfhydryl groups in the animal organism. This statement, coupled with the fact that thiouracil and its derivatives have a potential sulfhydryl group in their molecules, led us to investigate the possibility that such drugs would protect animals against the lethal effects of roentgen radiation. Furthermore, it was possible that the effect of such drugs could be enhanced by longer premedication periods than those employed by Blount and Smith (*1*).

protection was produced by these drugs. It is possible that the potential sulfhydryl group in the thiouracil compounds was unavailable, and thus combination could not take place between it and similar groups in the animal organism.

Statistical evaluation of the mortality data in Table 1 by the method of Litchfield (*5*) reveals that the slopes of the curves for a given experiment are almost identical. Furthermore, in a given experiment and between different

TABLE 1

RESPONSE OF NORMAL AND HYPOTHYROID MICE TO ROENTGEN RAY IRRADIATION

Drug	Total mortality					Approx. LD_{50}/day‡					Total drug ingested in mg (av. values)**				
	C†	1	2	3	4	C†	1	2	3	4	C†	1	2	3	4
Thiouracil	6/10*	10/10	9/10	7/10	8/10	11	8.5	13	14	12	0	65	122	174	292
Propyl thiouracil	9/10	10/10	8/10	10/10	5/7	13	8.5	9.2	12	12.5	0	39	98	132	200
	10/10	10/10	10/10	10/10	9/9	10	10	9	11	13	0	52	128	189	260
Methyl thiouracil	9/10	9/10	9/10	7/9	7/10	13	11	12	15	12.5	0	79	160	264	316

* Ratio signifies number dead over total number of mice in group.
† Control; 1, 2, 3, 4 signify number of weeks of antithyroid premedication.
‡ Day upon which 50% of the group died because of irradiation. ** Mg of drug/mouse/week.

Adult male mice, CF #1 strain, weighing 20–33 g (av. 23 g), raised in our own colony, were divided into 5 groups of 10 animals each and caged individually as described by Bratton (*2*). The control group received plain tap water, and each of the other groups received 0.1% of the antithyroid drug in their drinking water for periods varying from 1 to 4 weeks. These drugs were solubilized by the use of an equimolar quantity of sodium bicarbonate and heat. In each experiment all the mice were irradiated as a single group in a cage similar to the one previously described for guinea pigs (*4*). Upon completion of the 28-day premedication period, the animals were subjected to 550 r acute whole body roentgen ray irradiation. The technical factors were: 250 kv, 15 ma, TSD 100 cm, filters: 0.21 mm Cu inherent, 0.5 mm Cu parabolic, and 1.0 mm Al; HVl 1.85 cm Cu, size of field—total body; r/min measured in air 9.06–9.70. Uniformity of dosage was insured by rotating the radiation cage during treatment. The 250 kv Picker Industrial Unit used was calibrated before each experiment with a Victoreen Thimble r-meter. After irradiation the animals were maintained on their ordinary diet (Rockland pellets) and received no further antithyroid medication. Autopsies were performed upon all animals that died during the 30-day experimental period and upon all survivors at the end of that time. The usual signs of radiation damage (diarrhea, bloody stools, petechial hemorrhages, pale mucous membranes, etc.) were observed in all the irradiated animals. Gross examination of the thyroids of the medicated animals showed the usual signs of antithyroid medication, the over-all effect being greater with the longer premedication periods (3 and 4 weeks). Details of the results are given in Table 1.

Although Table 1 shows that large amounts of antithyroid compounds were ingested, it is evident that no experiments, there is relatively little difference in the radiation LD_{50} day (50% radiation mortality), and thus there is little difference in the susceptibility of normal and hypothyroid animals to roentgen ray irradiation damage. This indicates that the mechanism involved in both the normal and the hypothyroid animal is probably the same, and that the hypothyroid state confers no real protection on the animal. It is well known that in the hypothyroid state there is a diminished utilization of oxygen as compared to the normal. However, Zondek (*7*) has shown that there is very little difference in oxygen saturation and oxygen tension in the normal and the hypothyroid states and that the oxygen dissociation curves in both states are almost identical. Thus it is possible that the amount of free oxygen, and not its rate of utilization, determines the extent of damage produced by roentgen ray irradiation. This would be in accord with the statement of Dowdy, Bennett, and Chastain (*3*) that roentgen ray irradiation damage is the result of radiochemical reactions involving free oxygen.

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Biological Studies on Cortisone in Mice[1]

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The reported dramatic effects of cortisone in clinical application on such a varied group of disease entities as rheumatic fever, rheumatoid arthritis, lupus erythematosis, asthma, and leukemia have led us to study the physiological mechanism of its action. The present report concerns itself with experimental observations in mice on the influence of cortisone on the formation of granulation tissue (its initiation and continued development), the activity of the reticuloendothelial system, and the formation of acute inflammatory exudate.

Influence of cortisone on granulation tissue. Ragan *et al.* (*2*) demonstrated an inhibitory action of cortisone on granulation tissue production in surface wounds on the ears of 6 rabbits. Histologic examination was made late in the process of wound healing, i.e., 5th and 8th days, postoperatively. Similar effects were not obtained by these investigators in rats. In our studies we examined the process of granulation tissue formation from its initiation, as well as the action of cortisone on granulation tissue already well along in formation.

Forty Swiss albino mice (20–25 g) from a bartonella-free strain, were bacteriologically controlled for enteric and respiratory latent infection, housed in individual cages, and kept under controlled conditions.

Following standard surgical techniques, wounds were made with a special instrument that simultaneously produces 2 circular wounds of uniform diameter (0.5 cm) and depth, including the skin and subcutaneous tissue down to the fascial plane of the dorsal muscles.

Based on weight distribution and sex, the mice were divided into a control group of 20 mice (40 wounds), injected subcutaneously with the diluent twice daily, and a treated group of 20 mice (40 wounds), injected subcutaneously with 1.0 mg of cortisone twice daily. Injections were started 24 hr prior to wounding and continued until 4 hr prior to sacrifice in each case.

Four mice in each group were sacrificed on the 1st, 2d, 3rd, 4th, and 5th days following wounding. The total cortisone dose for each mouse in the groups as sacrificed was 4, 6, 8, 10, and 12 mg, respectively. The wounds were completely excised, formalin-fixed, sectioned, and stained with H. & E. and toluidine blue. Complete autopsy was performed on each animal.

Microscopic examination of these wounds revealed a complete suppression of all elements in wound healing of the cortisone-treated group as compared with the control group. Wounds examined after 24 hr (8 wounds in each group) revealed an almost complete lack of exudate and fibrin in the cortisone-treated group. All cellular elements were markedly diminished. As the days progressed, comparable studies revealed very little new capillary formation, sparse fibroblastic proliferation, and scant ground substance present in the cortisone-treated group. By the 5th and final day of this study, the majority of the wounds in the control group showed considerable compact, well-vascularized granulation tissue—almost, if not completely, covered with epithelium—whereas in the cortisone-treated group scant collections of fibroblasts were present. In some of the cortisone-treated animals, however, epithelization was complete, and bare adipose tissue surfaces were practically covered (Fig. 1, *A–D*). The effect on the healing of wounds was in many respects similar to that seen in vitamin C depletion, in particular, the absence of ground substance as demonstrated by the toluidine blue stain.

Influence of cortisone on existing granulation tissue. In several instances, clinical investigators have referred to an alleged fibrolytic activity of cortisone to account for beneficial effects in arthritis and for harmful effects on pulmonary tuberculosis. To determine whether such a fibrolytic property exists, 20 mice from the same herd were wounded as described above and divided into 2 groups of 10 mice each. Seventy-two hr after wounding, the treated mice were injected subcutaneously with 1.0 mg of cortisone twice daily; control mice were given the diluent only.

In each group, mice were sacrificed as follows: 3 mice (6 wounds) on the 5th and 3 on the 6th day after wounding; 4 mice (8 wounds) on the 7th day after wounding. The total cortisone administered per mouse was 4.0 mg, 6.0 mg, and 10.0 mg, respectively.

Comparative histologic examination of the wounds did not reveal any significant quantitative or qualitative differences in the composition of the granulation tissue compared on the basis of new capillary formation, intercellular substance, fibroblastic proliferation, and compactness of the granulation tissue. There was no evidence of lysis of already existing granulation tissue.

Influence of cortisone on the phagocytic action of the reticuloendothelial system. Fourteen mice selected from the same strain and herd were separated into 2 equivalent groups and pretreated for 2 days with 1.0 mg of cortisone twice daily; the control animals received equal volumes of the diluent. This injection treatment was maintained for each mouse until the day of sacrifice. On the 3rd and 4th days of injection, all mice in both groups were injected with 0.5 ml of carbon particles (India ink) intraperitoneally. On the 5th day, 4 hr after injections of cortisone and diluent, all mice were sacrificed.

The peritoneal cavity and visceral organ surfaces of each of the cortisone-treated mice were diffusely covered with grossly visible carbon particles throughout. The control mice showed only occasional foci of carbon particles on the surface of the liver or spleen, and most of the carbon particles were found in the omental, mesenteric, and retroperitoneal regions. The superior mediastinal lymph nodes of the untreated mice were readily identified by their content of carbon particles,

[1] Cortisone was allocated by the Committee for the Investigation of Cortisone of the National Academy of Sciences.

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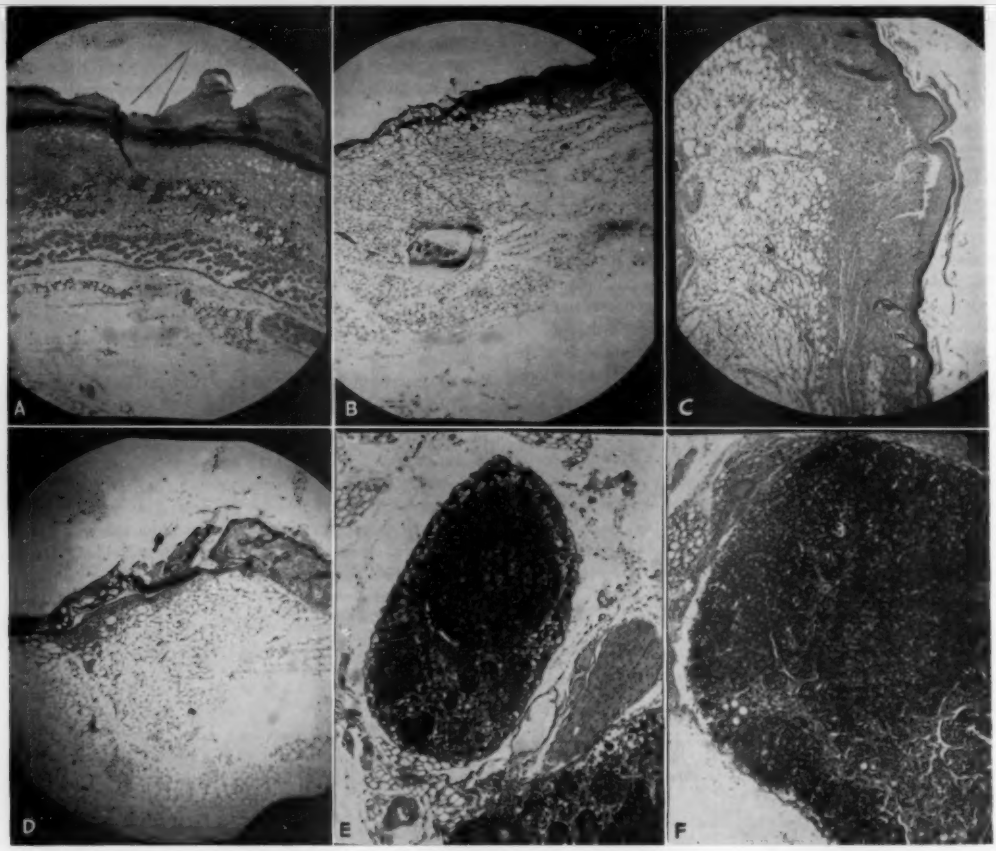

FIG. 1. *A*, photomicrograph of 24-hr wound in control animal, showing usual amount of fibrin and cellular reaction; *B*, 24-hr wound in cortisone-treated animal, showing paucity of fibrin and cellular reaction; *C*, 5-day wound in control animal, showing abundant compact granulation tissue; and *D*, 5-day wound in cortisone-treated animals showing scarce granulation tissue. *E*, mediastinal lymph node in control animal showing carbon particles in macrophages; *F*, mediastinal lymph node in cortisone-treated animal showing no carbon particles in macrophages.

whereas in the cortisone-treated mice the nodes were difficult to locate and contained no carbon particles, except in one instance in which a very small amount of carbon was seen. These gross findings were confirmed by microscopic examination (Fig. 1, *E*, *F*).

An interesting side observation was that the spleens of the cortisone group were 1/5 the size of those in the control group (*1*).

Influence of cortisone on acute inflammatory exudate. Clinical reports on the action of cortisone in affecting the resolution of the acute inflammatory exudate of pneumonia prompted us to investigate the development of acute inflammatory exudate in normal cortisone-treated mice.

Ten mice from the same herd and strain as before were divided into 2 groups of 5 each. Pretreatment with cortisone (1.0 mg twice daily) and, in the case of control mice, with equivalent volumes of diluent, injected subcutaneously, was given for 3 days. Total cortisone injected was 8.0 mg/mouse. Four hours after the 7th injection of cortisone and diluent, each mouse was given 0.2 ml of turpentine intracutaneously on a prepared and marked area of the abdominal wall. One additional injection of cortisone and diluent was administered 4 hr later. All animals were sacrificed 18 hr later. The area of turpentine injection was excised, sectioned, and examined microscopically. There were no differences observed in the acute inflammatory exudate between the cortisone-treated and control mice.

Unquestionably, cortisone inhibits the formation of granulation tissue. It appears that the effect is rapid after administration and is of short duration. Significant interference with the formation of granulation tissue occurs only when the cortisone is administered during the early stage of initiation of the repair stimulus. No appreciable effect is noted on already existing granu-

lation tissue. This tends to vitiate usefulness of cortisone as a fibrolytic agent in diseases such as silicosis, scleroderma, etc. It would be harmful to administer cortisone alone in diseases such as tuberculosis, where the fibrous tissue response must not be inhibited.

Cortisone treatment in mice results in a definitely retarded macrophage response. Whether this is due to the diminution of activity of the individual cell or to the depletion or mobilization of the total number of cells could not be determined in the above experiment. Some evidence of total depletion is indicated in our finding (*1*) that administration of cortisone results in a marked reduction of the total cellular content of the spleen. The retardation of the macrophage response may result in a potentially undesirable situation in certain disease processes, e.g., in tuberculosis. Another factor in the retardation of the removal of carbon particles may be due to the stimulation of antihyaluronidase activity by cortisone. This has been reported by Seifter and associates (*3*).

No effect of cortisone on the early formation of acute inflammatory exudate in response to turpentine was noted. This experiment was limited to the early response and did not control the rate of resolution. This question is at present under study by us.

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Additional Confirmatory Evidence of the Rediscovery of the Old Italian Varnish

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In an investigation to rediscover the "lost art" of making the old Italian varnish used centuries ago by the celebrated violinmakers, Stradivarius, the Amati, and others, it was learned from spectrographic analyses (*3–5*) that a number of elements were frequently present in their varnish. The principal elements in the brown varnish were aluminum, iron, silicon, sodium, calcium, magnesium, lead, and manganese, in the order named. Aluminum, iron, and silicon were present in *all* twelve specimens of brown varnish analyzed. The presence of every element, excepting silicon, has been explained, but the unexpected and constant appearance of silicon was perplexing. Moreover, any valid rediscovery of the so-called secret of Stradivarius must account for all the facts. A satisfactory explanation for the presence of silicon thus became necessary.

In 1946 the writer (*2*) proposed that the old Italian violinmakers used metal rosinates in their varnishes and that they, or the alchemists and apothecaries of their time, could have prepared these resins in the following manner. Ordinary rosin was first dissolved in potassa lye extracted from wood ashes, the principal source of alkali in those bygone days. The metal rosinates were then obtained simply by precipitation with a solution of a metal salt such as alum (aluminum-potassium sulfate) or copperas (ferrous sulfate). Since silica or silicates are always present in wood ashes, it was suspected that these might also be the source of the silicon found in the varnishes. The silicon would thus serve as a telltale element that should shed light on the method and the materials employed in making the old Italian varnish.

Theoretical considerations. The extraction of alkali from wood ashes is almost a forgotten art, so it may be of interest to delve briefly into the process. The soluble alkali in the ashes was extracted by three methods: (*a*) extraction with water, which yielded the alkalis in the form of carbonates; (*b*) subsequent addition of lime to this solution, which yielded a stronger lye, but which required two operations or filtrations; and (*c*) extraction of the wood ashes with water and lime (milk of lime), which yielded the lye solution readily with only one filtration or decantation. It would be necessary to boil the carbonate solution obtained from method (*a*) to dissolve rosin; the stronger lyes (potassium and sodium hydroxides) dissolve rosin in the cold. Thus, method (*c*) is simple and direct and is the most likely and logical method that the ancients might have used to prepare their lye solutions to dissolve rosin.

The alkali hydroxides formed in method (*c*) should also dissolve some of the silica present in the wood ashes, converting the silica into soluble alkali silicate. The silicate would in turn be precipitated when the alkali rosinate solution reacted with the metal salt solutions in the precipitation of the metal rosinates. The chemical reactions are as follows:

$$K_2CO_3 + CaO + H_2O = CaCO_3 + 2KOH$$
$$SiO_2 + 2KOH = K_2SiO_3 + H_2O.$$

Experimental results. Only materials and methods fully justified by recorded writings preceding and contemporary with the period in which the old Italian varnish was in existence (A.D. 1550–1750) were used in this research. Well-burned wood ashes were digested overnight with water to which lime (CaO) had been added, and the mixture was filtered through cloth which yielded a water-white filtrate. Freshly powdered rosin in small amounts was then added to the filtrate in the cold, with occasional shaking until an excess of rosin remained; upon standing a few days, clear, amber-colored solutions were obtained; undissolved pieces of rosin were filtered off and weighed. The results of several extractions are summarized in Table 1.

An alum solution or a solution of alum and copperas was then added to the alkali rosinate solution until an excess of the precipitant was present. The mixture was heated on a water bath, which caused the precipitated metal rosinate to coalesce and expedited filtration through cloth. The resulting air-dried resins were freely soluble in turpentine, and these solutions gave glass-clear films upon drying.

[1] The kindness and cooperation of Alan Goldblatt, director, Chicago Spectro Service Laboratory, Chicago, Ill., in making the spectrographic analyses, are gratefully acknowledged.

TABLE 1

WATER EXTRACTION OF ALKALI IN WOOD ASHES

Extract No.	Wood ashes, g	Water added, ml	Lime added, g	Filtrate obtained, ml	Rosin dissolved, g
6	10.0	100	4.0	73	2.7
11	30.0	300	12.0	240	10.0
12	30.0	300	12.0	230	9.8

Varnishes were prepared from these resins and raw linseed oil, using turpentine as the solvent. The varnishes were perfectly transparent and were identical in properties with similar varnishes previously described (*2*) that satisfied the criteria demanded for a re-creation of the old Italian varnish. A brown varnish was prepared as follows:

Preparation of resin: 65 ml alkali rosinate solution and 31 ml solution containing aluminum and iron sulfates.

Preparation of varnish: 2.0 g Al-Fe rosinate dissolved in 4.0 ml turpentine, to which 2.0 ml raw linseed oil was added.

Goldblatt (*1*) subjected the dried film from this varnish to a spectrographic analysis, and the results are reported in Table 2.

TABLE 2

ANALYSES OF A RE-CREATED ITALIAN VARNISH AND A STRADIVARIUS VARNISH

Element present	Re-created varnish, %	Stradivarius varnish, %
Al	0.1 –1.0	0.08 –0.8
Fe	.05 –0.5	.01 – .1
Si	.05 – .5	.08 – .8
Ca	.01 – .1	.03 – .3
Mg	.005 – .05	.01 – .1
Cu	0.0001–0.001	0.005–0.05

The spectrographic analysis of the Stradivarius varnish, also by Goldblatt, has been previously reported (*5*), and the elements common to both analyses are included in Table 2 for comparison purposes.

The two analyses are significant for several reasons. The cause of the presence of silicon in the old Italian varnish has been explained. A fairly pure grade of lime was used in the extraction of the alkali from the wood ashes; the silicon content in the re-created varnish would have been higher if lime produced from siliceous limestone had been used. The alum and copperas were pure chemicals; these materials as they were produced centuries ago no doubt contained impurities that would introduce other elements into the varnish. The explanation for the presence of silicon supplies information as to the method and the materials that might have been used by the old Italians in the preparation of their varnish.

Only the wet, or precipitation, method has been considered in this preparation of the resin for the brown varnish. Metal rosinates can also be prepared by the dry, or fusion, method. When rosin with or without linseed oil was heated with sienna, ochre, and umber (pigments containing aluminum, iron, and silicon), the resulting resins did not contain sufficient silicon, and the varnishes were usually turbid, even after prolonged standing. This, too, would indicate that the precipitation method was the one used for the preparation of the resins for the brown varnish. The possibility does exist, however, that the colorless varnish and some of the other colored varnishes were prepared by the fusion method (*4*).

The similarity of the analyses of the re-created varnish and the Stradivarius varnish in Table 2 is also noteworthy. A varnish has now been prepared that compares favorably in the composition of a group of its constituents with the varnish used by the celebrated master. The similarity of the re-created varnishes to the old Italian varnish with respect to color, permanence of color, transparency, and other properties has already been reported (*2*).

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Summer Growth of the American Oyster in Florida Waters[1]

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Various investigators (*3, 4, 5*) have found that the American oyster *Ostrea virginica* grows an average of 1 in. per year in water north of, and in, Chesapeake Bay. Usually the growth is greater than 1 in. the first year but declines in subsequent years. This growth takes place only during the summer months, and it has been shown by Loosanoff (*2*) that there is no increment during the winter months.

In the Apalachicola Bay area a study is being made of the growth of *O. virginica* in Florida waters. The object of this investigation is to provide data on the growth of all sizes of oysters at all seasons of the year. Results of studies made during the summer season (May–October, 1949) indicate that growth in Florida waters is considerably more rapid and more extended than that observed in northern waters. No other recorded data on growth rates of Florida oysters have previously been published.

Growth of oysters from time of setting to 6 weeks of age was observed on spat that adhered to shell contained in wire baskets of the type commonly used in the study of oyster spawning (*1*). Studies on growth of oysters 11–16 weeks of age were made on individuals that adhered to cultch. Oysters 16–31 weeks of age were studied by

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[2] On leave from Marine Laboratory, University of Miami.

TABLE 1

SUMMARY OF MAXIMAL OYSTER GROWTH-RATE STUDIES APALACHICOLA BAY, FLORIDA

Experiment	Age, weeks	Date measured	Size, mm	Period in weeks	Increment	Weekly increment
Wire baskets planted May 26, 1949	1	6- 2-49	4.5	1	4.5	4.5
	2	6- 9-49	8.0	1	3.5	3.5
	3	6-16-49	11.7	1	3.7	3.7
	4	6-23-49	21.0	1	9.3	9.3
	5	6-30-49	29.9	1	8.9	8.9
	6	7- 7-49	34.1	1	4.2	4.2
Cultch planted June 6, 1949	11	8-21-49	47.1			
	15	9-18-49	62.4	4	15.3	3.8
	16	9-25-49	68.1	1	5.7	5.7
Gowth-rate trays*	16	7- 8-49	70.0			
	25	9- 9-49	88.0	9	18.0	2.0
	31	10-21-49	104.0	6	16.0	2.7

* Approximate age calculated from previous data.

placing them in trays. All readings were made upon well-rounded individuals. No crowded or elongated oysters were used. A summary of the maximum growth attained by the various age groups is given in Table 1.

It is shown in Table 1 that a length of 1 in. is achieved in Florida in 5 weeks. This is nearly a year's growth in northern waters. Moreover, a length of 4 in. is attained in Florida during 31 weeks of the warm season, whereas an equal growth in northern waters would require approximately 4 years.

During the period of this study, the salinity averaged 26.3 parts per thousand (range: 12.7–33.6). The mean temperature of the water was 28 °C (range: 26–30.5).

A more detailed account of these growth-rate studies will be published elsewhere.

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A Micromacerator

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This tissue macerator has proved itself very useful in the rapid reduction of embryonic or other tissues to a fine uniform emulsion prior to the preparation of tissue extracts. The particles so produced are small enough so that, when stained smears of the product are examined under the microscope, very few whole cells or nuclei can be found.

A 10-cc glass syringe is the main item required for the manufacture of this macerator. The cylinder, which is to act as the rotor, is set into a base receptacle cut to form from a No. 8 rubber stopper, as shown in cross section in Fig. 1. A hole 1/10 in. in diameter is drilled into the center of the stopper to a depth of ¾ in., and then enlarged to a depth of ¼ in., so that the base of the cylinder may be snugly fitted into it while the tip projects deeper into the smaller hole. It is preferable to use the smaller end of the stopper for this step. Another ¼-in. hole is drilled into the center on the other side to a depth of ¼ in.

[1] Acknowledgment is given to K. M. Richter, associate professor of histology and embryology, for his assistance and suggestions, and to the Department of Physiology for the use of equipment.

The stator is constructed from the piston portion of the syringe. By means of a glass-cutting saw or grinder, a shallow groove is cut around the outer circumference of the piston at a distance of about 2½ in. from the lower end. At two points in the groove, and located diametrically opposed one another, holes ⅛ in. in diameter are drilled through the wall and into the inner chamber of the hollow piston. Another hole, large enough to permit the entry of a No. 00 rubber stopper, is cut into the head end of the piston.

The receptacle for the head end of the stator is prepared as shown in Fig. 1. A hole is bored through the center of a No. 10 rubber stopper just large enough to hold the wide end of the No. 00 stopper. The hole at the narrow end of the No. 10 stopper is further enlarged to fit over the head end of the stator as illustrated. A piece of glass tubing, 2 in. long, is cemented into a hole bored through the No. 00 stopper.

To operate the instrument, about 2 cc of tissue is placed in the bottom of the cylinder, and the air is expelled by pushing down the plunger while the needle-holding tip is pointing upward. The tip and base are then firmly pushed into the rubber stopper receptacle, thus sealing off the tip. The glass tube is connected to a vacuum system by means of a rubber tube. The lower hole and the rubber base of the rotor are centered on the chuck plate of a medium-speed electric motor, in either vertical or horizontal position. The rubber headpiece of the stator is gripped in the hand and the motor is switched on. A gentle pressure is exerted on the stator

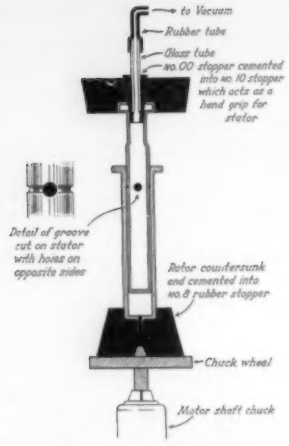

FIG. 1. Micromacerator.

so as to allow a period of about 1 min to elapse for the total displacement of the tissue by the descending piston.

The tissue is thus slowly forced between the two closely opposing ground glass surfaces of the stator and the rapidly rotating rotor. As it creeps up in this limited space, it becomes totally emulsified. When it reaches the groove cut on the surface of the stator, it is drawn through the holes and into the inner chamber by means of the applied vacuum. When all the tissue has been ground, the motor is stopped, the headpiece is removed from the stator, and the ground tissue is emptied into a centrifuge tube for separation or further treatment.

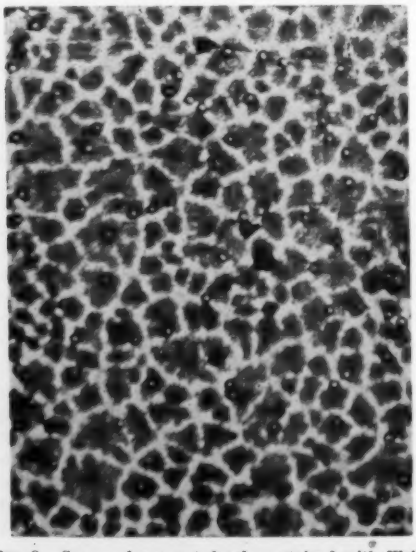

FIG. 2. Smear of macerated spleen stained with Wrights' stain. Suspension of red blood cells superimposed on preparation for comparison. × 315.

The macerator is easily cleaned and sterilized by autoclaving. No perceptible heat is produced by friction during the grinding process, and no instrument has broken during operation. Caution must be exercised to make certain that the base is well centered, and that it will rotate in line with the central axis of the motor shaft so that no eccentric motion occurs. This model may be constructed in any size, depending upon the volume of work that is required of it. For larger models employing this principle, however, it is preferable to machine the grinding surfaces from stainless steel.

Fig. 2 shows a stained smear of spleen tissue ground in this apparatus. The red blood corpuscles were added to the emulsion after grinding to help make a comparison of the size of the particles produced.

Relationship Between Glomerular Filtration Rate and Urine Flow in the Rabbit

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Administration of water to rabbits is followed by a marked increase in glomerular filtration rate (GFR) (*11*, *12*). Dicker and Heller (*7*), and Forster (*10*), have shown that this rise of GFR is accompanied by an increase in effective renal plasma flow (RPF). Such a participation of the glomeruli in the regulation of the urine volume of normal adult animals has so far not been found in any other mammalian species. It cannot be said to be characteristic for either rodents or herbivores, as neither adult rats (*7*) nor adult guinea pigs (*8*) show a correlation between GFR and urine flow. Such a relationship has, however, been found in amphibians (*9*, *13*), young and newborn rats (*5*, *6*), and newborn guinea pigs (*7*). It has also been claimed to occur in newborn infants (*1*, *4*), but see Barnett *et al.* (*2*).

The phenomenon has been interpreted (*14*) as a physiological response of glomerular function to an increased body-water load. However, this interpretation has recently been questioned by Brod and Sirota (*3*), who believe that "the parallel variation in urine flow and filtration rate . . . is attributable to a reduction in renal blood flow occasioned by the experimental procedures." They assume that injections and administration of water preceding clearance estimations in rabbits are stimuli sufficiently noxious to produce a decrease in urine flow, RPF, and GFR, so that the rising GFR values observed are due to recovery from the oliguric phase. Brod and Sirota's interpretation, if substantiated, would be of considerable interest. In our experiments on rabbits, however, the urine-collecting period started 3 hr after the injection of inulin and diodone and 1 hr after the last administration of water. It is difficult to believe that such harmless procedures would give rise to emotional disturbance in rabbits for any prolonged period. But, even on Brod and Sirota's assumption, disturbing effects of experimental procedures should have passed by

the time the rabbit reached the peak of the diuresis. It seemed, therefore, of interest to investigate the relationship between GFR and urine volume, when the urine output was falling after full diuretic values had been reached.

TABLE 1

Increasing rates of urine flow				Decreasing rates of urine flow			
Urine flow (ml/100 g/min)		GFR (ml/100 g/min)		Urine flow (ml/100 g/min)		GFR (ml/100 g/min)	
From	To	From	To	From	To	From	To
0.0226	0.0510	0.52	0.60	0.0510	0.0029	0.52	0.04
.0143	.0502	.41	1.08	.0474	.0200	0.29	.18
.0057	.0389	.18	0.54	.1040	.0100	1.25	.23
.0093	.0316	.18	0.35	.0316	.0017	0.35	.19
.0009	.0811	.10	1.03	.0100	.0015	0.23	.08
.0423	.0687	.37	1.08	.0420	.0095	0.52	.10
.0420	.0965	.42	1.28	.0818	.0020	1.03	.12
.0220	.1060	.37	1.63	.0222	.0023	0.37	.15
.0365	.1080	.30	1.72	.0605	.0200	0.93	.43
.0180	.0960	.10	0.99	.0100	.0055	0.20	.05
.0220	.0570	.18	0.78	.1050	.0320	1.37	.56
.0140	.0552	.25	0.61	.0547	.0183	0.63	.31
.0457	.0920	.32	0.89	.0286	.0077	0.35	.06
.0085	.0990	.05	1.09	.0816	.0316	0.83	.45
.0057	.0389	.18	0.54	.0316	.0275	0.40	.33
0.0075	0.0275	0.05	0.35	0.0547	0.0115	0.60	0.15

On looking through the experimental results on which our report on renal function in the rabbit was based (*7*), it was found that 16 pairs of GFR estimations had been done at decreasing rates of urine flow. It will be seen from Table 1 that much the same relation between GFR and urine flow obtains at falling, as at rising, rates of diuresis. This may be exemplified by the results on an animal in which three consecutive clearance estimations had been performed: when urine output increased from 0.0093 to 0.0316 ml/100 g/min, GFR rose from 0.18 to 0.35 ml/100 g/min; when, in the same animal, urine flow decreased from 0.0316 to 0.0017 ml/100 g/min, GFR fell from 0.35 to 0.19 ml/100 g/min. On the other hand, no significant changes were observed in those animals whose rate of urine excretion happened to remain steady over an extended period (*A*, Table 2), though it will be noted that in these animals, also, the level of glomerular filtration corresponded to that of the urine flow. In two animals, correlation between GFR and urine flow was found to be lacking (*B*, Table 2).

TABLE 2

Rates of urine flow (ml/100 g/min)	Corresponding rates of GFR (ml/100 g/min)
A	
0.0501—0.0532—0.0510—0.0541	0.49—0.50—0.54—0.48
.0907— .0888—0.0932	.99—1.08—0.97
0.0055—0.0055	0.08—0.09
B	
0.0350—0.0212—0.0283	0.39—0.28—0.47
0.0300—0.0105—0.0054	0.31—0.33—0.30

It would seem from these findings that the regulation of urine volume in most adult rabbits is of a twofold nature, comprising (*a*) a tubular regulatory factor, in common with all other mammalian species, and (*b*) a glomerular component, which perhaps comes into play when the body-water load is substantially raised. The observation that GFR rises with increased, and falls with decreased, urine flow inclines us to think that these variations are a physiological rather than a pathological response. The fact that glomerular filtration rate and urine volume are similarly related in the newborn of other mammalian species supports this conclusion.

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Electrometric Correlates of the Hypnotic State

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Because of repeated failure to detect electrometric correlations with EEG from trance states (*1, 4, 6–8*), no completely objective criteria of hypnosis have yet been formulated beyond empiric observation. Using a Burr-Lane-Nims microvoltmeter (*2, 3, 5*), 60 standing potential records of 20 subjects were taken. Although results of spot determinations were sometimes equivocal, continuous emf tracings, using the combined microvoltmeter and General Electric photoelectric recorder (*5*) at a speed of 1 in./min, with one electrode on the forehead and the other on the palm of either hand, seem to provide a reliable quantitative index of trance depth. During hypnosis, the emf tracing becomes more regular, and potential difference either gradually increases or decreases in magnitude. At trance termination, there is usually a dramatic voltage shift, and the tracing eventually returns to that of the normal waking state (Fig. 1).

Whenever possible, induction was linked up with motor

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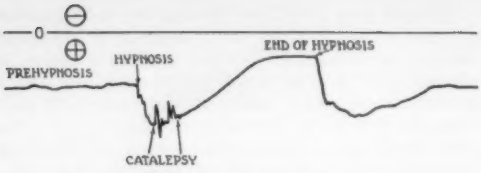

FIG. 1. Schematic d-c record of hypnosis.

behavior, utilizing the technique developed by Milton H. Erickson; e.g., as his hand rose, a subject would become sleepier until, finally, when it touched his face, he would close his eyes and sleep, signifying he was ready by returning the hand to his lap. Catalepsy, when used to induce hypnosis, sometimes produced marked emf changes (Fig. 1). When this occurred during the trance, or when the subject voluntarily raised an arm, minimal changes were recorded.

Depth of hypnosis, as measured electrometrically, does not seem to be correlated with ability to develop amnesia or other phenomena often necessary for a good therapeutic trance. Any disturbance of the hypnotic state could be detected immediately by changes in voltage and in configuration of the tracing. It is thus possible to measure objectively changes in depth of hypnosis.

A complete report of methodology and results will be published elsewhere.

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Comments and Commuications

Are Nonflying Wings Functionless?

In a recent able review of evidence that the so-called ratite birds had flying ancestors, Steiner (*Rev. Suisse de Zool.*, 1949, **56**, 364) concluded with the remark (in German) that "the wing, made useless by the transition to a cursorial habitus, was reduced as a direct result of its high specialization, because it was no longer capable of taking on a new function (in *Rhea* and *Struthio* at most still used for display of the decorative wing feathers!)."

There is nothing new in the observation, but it is worth while to point out that even so highly specialized a structure as the bird wing is quite capable of taking on functions distinct from, although usually related to, that of aerial flight. The penguin wing is certainly a highly functional organ. Loss of ancestral power of flight in this case clearly involved change, not loss, of wing function (Simpson, G. G. *Bull. Amer. Mus. Nat. Hist.*, 1946, **87**, 1). The same is probably true of some or all of the distinctly cursorial flightless birds.

The rhea is among such truly cursorial birds, a running herbivore (and occasional insectivore) adapted to treeless plains where large predatory carnivores are present, and this also applies to the African ostriches. Long personal observation of wild Patagonian rheas in their natural habitat did not disclose any definite display of the wing feathers, although this may occur. Repeated observations did confirm the fact that the wings are not wholly passive and that they probably do serve a useful function. When running, the rheas keep the wings spread and seem definitely to balance themselves in this way, especially in the rather awkward maneuver of turning rapidly.

This true function for the reduced wings may well explain the rule that the wings are usually merely reduced and not lost altogether in cursorial birds. It is true that the wings were completely functionless and were lost externally in the moas of New Zealand and in *Aepyornis* and its allies in Madagascar. These birds, however, were probably not truly cursorial types, as suggested by their heavy, evidently slow proportions, their herbivorous habits, and their practical immunity from predation except by man, whose persecution was too late and too brief to induce cursorial adaptation. Among other extinct birds, the phororhacoids in South America, *Diatryma* in North America, and *Gastornis* in Europe all had cursorial proportions. All were associated with mammalian predators, and they were themselves probably running predators. All retained reduced but probably functional wings more or less as in the rheas.

It is a habit of thought to consider that changes associated with reduction in size and loss of a function, as in nonflying wings, are *ipso facto* degenerative. The modifications of the penguin wing can, however, be viewed as progressive specializations for their new function. May this not also be true of the rhea wing and analogous cases?

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The *Systema Naturae* of the Twentieth Century

If the International Zoological Congress, to meet in Copenhagen in 1953, decides to allow another interval of five years before its next meeting, the latter will fall in 1958. It will be 200 years after the issue of Linnaeus' tenth edition of his *Systema Naturae*, an anniversary which must not pass without a serious attempt being made to bring the ideas of this great naturalist a new step forward.

How it could be done is indicated by Karl P. Schmidt (*Science*, 1950, **111**, 235), who writes that we could create a *Systema Naturae* of the twentieth century by having the *Official List of Generic Names* brought up to date and efficiently extended.

I feel that Linnaeus might have signed the following words of my regretted friend Cyril Crossland, when he wrote in a letter printed for circulation among systematists during the war (1940):

> Systematists do not work for themselves alone, indeed if it were so their work would be of the most useless sort, and a waste of public money. It is, in fact, in every way the reverse. It is a part, and a fundamental part, of the great whole of biology. On this foundation rises a vast superstructure of such things as ecology, evolution, genetics, agriculture and medicine, which without it, are a chaos of loose stones. Species workers only exist in order that others may be able, with the least possible loss of time and labour, to find out all that is known about the relations of a species to its fellows, its structure, distribution, and habitat. If they put difficulties in the way they stultify their own work and their own existences.

This is the way any systematist should feel the responsibility of his task.

The ultimate aim of the *International Rules of Zoological Nomenclature* should be to have an unchangeable system of names of all animals. Everybody will agree that such a system is very far off, if nothing is done to bring it nearer.

When 1758 was fixed as the starting point of zoological nomenclature, it was quite an arbitrary date. It did away with many older authors and gave credit to Linnaeus in a way he himself probably never thought of; this was when it was decided that a generic or specific name should be followed by the author's name. A widespread mental disease among systematists was the deplorable result, the *Mihilisme*. In many cases this disease can only be cured by an operation; this has been done by placing the systematic names on the *Official List* (O.L.)—and with good results, as far as the O.L. is known, but this is hardly beyond the narrow circles of systematists. To be of any real value, it must be considerably extended and comprise a few thousands of names, selected from textbooks on physiology, embryology, ecology, etc. These names should form the *Systema Naturae* of the twentieth century, a book to be found in any biological laboratory. Any name used in reference to this book should be cited by adding "O.L." beside the author's name; e.g., *Gadus* Linnaeus 1758 (O.L.). Nobody would have difficulty in checking the exact significance of the name, and long lists of synonymic names could be avoided.

In view of the existence of the Vanity Fair of the Mihilists, I dare only dream about the day when we can write *Gadus* O.L. 1958, and the still more remote time when plain *Gadus* cannot be misunderstood because all names will have passed onto the O.L.

By that time all Mihilists will have been forgotten, while we will remember the outstanding systematists in the same way we remember outstanding physiologists, anatomists, etc., and for the same reason—their contribution to the structure of the great building of biology.

So let us have the *Systema Naturae* of the twentieth century.

ANTON FR. BRUUN

The Zoological Museum
University of Copenhagen

Book Reviews

Numerical Solutions of Differential Equations. H. Levy and E. A. Baggott. New York: Dover Publs., 1950. 238 pp. $3.00.

This is an American edition of a volume first published in England in 1934 under the title *Numerical Studies in Differential Equations.* Except for the title itself and the omission of Volume I from the cover, the present American printing and the original English text are identical in content. Everything was reproduced verbatim, including the preface which states among other things:

> This, the first volume, concerns itself only with the actual solution of ordinary differential equations and the numerical examination of many of their properties. The determination of Characteristic Numbers (*Eigenwerte*) and the investigation of Orthogonal Properties in general are, however, omitted. These will be included in Volume II, since such properties are primarily of importance in connection with the practical solution of partial differential equations.

As far as the reviewer knows, no such second volume has ever appeared in print. It is indeed regrettable that the authors of this fine little volume on the numerical solution of ordinary differential equations have not been able to carry out their plans of writing a similar text for the numerical solution of partial differential equations—a field which, owing to recent developments in automatic high-speed computing machines, is rapidly becoming of vital importance in engineering and applied mathematics, and for which not a single text is yet in existence.

Since this book has been reviewed previously on a number of occasions, the reviewer will confine himself to a brief outline of its contents. The first two chapters deal entirely with graphical methods for the solution of ordinary differential equations. Certain geometrical properties that are useful in the application of graphical methods are discussed, and the solutions of a number of typical equations are carried out in detail.

Chapters III, IV, and V are devoted to the numerical solution of differential equations both by expansion in infinite series and by finite difference methods. Although the authors stress the application of these methods to special cases, which are carried out in detail and described with great clarity, these procedures are of general usefulness. Thus the Adams–Bashforth method, which is a general method for the numerical integration of differential equations, is taken up in a subsection

of Chapter IV entitled "Forward Integration of First Order Equations." Among the topics discussed in these three chapters are: the solution of simultaneous equations and equations of second and higher order, estimation of total error over the range of integration, a comparison of the accuracy of the various methods for integration by finite differences, and the solution of equations with boundary conditions given at two end points. The sixth and final chapter deals with some special methods applicable to the solution of linear differential equations.

In general the text is clearly written and illustrated with a great variety of typical problems, which are carried out in detail and which can be easily followed by a student at the college level. It fulfills a great need in this field which exists at the present time. For this reason its republication in this country should be welcomed as a timely venture which will prove extremely useful to many students in applied mathematics.

HARRY POLACHEK

Applied Mathematics Division
U. S. Naval Ordnance Laboratory

History of Physics. Max von Laue, Ralph Oesper, Trans. New York: Academic Press, 1950. 150 pp. $2.30.

Joseph Henry: His Life and Work. Thomas Coulson. Princeton, N. J.: Princeton Univ. Press, 1950. 352 pp. $5.00.

Max von Laue's life has spanned the great revolutionary period of modern physics. An authority on relativity and a pioneer in the theory of crystal diffraction of x-rays, whose classic contributions in both fields were published before World War I, von Laue continued his work during the years of Nazi tyranny, when he successfully, and at times courageously, refused to compromise with the dictates of racialized science. Few men did more to uphold the honor of German science in its darkest hour. It was with impatience that this reviewer waited for the appearance of a short history of physics which he learned von Laue was publishing in a series edited by Erich Rothacker. The German original appeared in 1947; the disappointment felt on seeing it has been confirmed, and if anything enhanced, by the appearance of the English translation, which is carelessly made from what seems to have been an earlier and less polished version than that finally issued in Germany! The ineptitudes of translation are numerous. Just why *Schwingungen* should be rendered "vascillations" is unclear, unless, like "statistics" for *Statik*, it involves a clerical error.

Von Laue's little book is arranged topically, and although he clearly is not very sympathetic to the earliest periods of the history of science, each section deals with the background history of its particular branch of physics. For those earlier branches which have a history running back of the 19th century, his treatment is not always satisfactory. His statement that "Nothing in either Antiquity nor the Medieval period points to any systematic scientific investigation" should apprise us that he is not aware of the important research historians of science have been doing in the past half-century. Yet this does not explain why he could not have consulted generally sound works in the history of physics like the books of Gerland, Rosenberger, and others, to avoid errors about the 17th and 18th centuries. Had von Laue not devoted so much space to this background, and lent the prestige of his great name to his statements, these points would hardly deserve mention. What is really enduring in this little book is von Laue himself and what von Laue tells us of the period he lived through. Here there is much useful material—especially in such chapters as the one on the physics of crystals—though the account is everywhere coldly factual and condensed. Since the first draft was completed before the news of Hiroshima, the question of atomic energy is scarcely mentioned, and, for once among recent publications, *Kernphysik* does not dominate the picture to the exclusion of other branches of modern physics. After the publicity about the successful large-scale release of atomic energy, von Laue added a perfunctory paragraph and cut out a sentence that has been translated: "Nuclear transformation can provide mankind with energy direct, though at present in not more than extremely modest quantities." Rather absurdly, this sentence, and the paragraph on thermonuclear reactions which includes it, have been retained in the translation, though they are not to be found in the German version.

Thomas Coulson's *Joseph Henry* is a conscientious work, written in rather undistinguished fashion, about one of the most interesting personalities in the history of science in America. Evidently the loss of the Henry papers by fire was a disaster of real magnitude to the biographer, for, although some use has been made of manuscripts in the Smithsonian Institution, it has been necessary to rely mainly on familiar sources—secondary biographical accounts and the published scientific papers—and no unsuspected reservoir of information has been turned up. Some relevant recent studies, like Carleton Mabee's life of Morse, were apparently not consulted. Coulson takes us in some detail through the researches of Henry's Albany and Princeton days and gives a good account of his important connection with the Smithsonian Institution, whose first secretary he was, and the National Academy of Sciences, of which he was one of the founders. The author's avowed aim of rescuing Henry from the neglect into which he has fallen has been achieved to the extent of presenting a most convincing picture of Henry's claim to a scientific reputation far beyond that which the 19th century, or our own, has accorded him. Coulson presents fairly Henry's claim to the prior discovery of electromagnetic induction and his share in the invention of the telegraph, but he seems to this reviewer to make perhaps a bit too much of Henry's interesting speculations of 1844—two years after the publication of J. R. von Mayer's paper—on the conservation and convertibility of energy.

HENRY GUERLAC

Department of History
Cornell University

News and Notes

Conference on the Properties of Semiconducting Materials

H. K. Henisch

Physics Department, University of Reading, England

This event took place at the University of Reading, England, July 10–15, under the auspices of the International Union of Pure and Applied Physics, in cooperation with the Royal Society. The conference, which was made possible through the financial support of Unesco, was organized by R. W. Ditchburn and N. F. Mott. H. K. Henisch acted as conference secretary and editor of the proceedings, which will be published in book form.

On the evening of July 10 approximately 230 visitors from Belgium, Denmark, Egypt, France, Germany, Holland, Israel, Italy, Sweden, Switzerland, the United States, and the United Kingdom were welcomed by the vice chancellor, J. F. Wolfenden, on behalf of the university, and by the secretary general, P. Fleury (France), on behalf of the union. Most of the conference members were accommodated in two of the university's halls of residence, which greatly facilitated informal discussions at times when the conference was not in session.

The formal proceedings of the conference were opened on the morning of July 11 by R. W. Ditchburn, after which N. F. Mott summarized some of the outstanding problems of semiconductor theory in his lecture. Later in the program E. J. Verwey (Netherlands) lectured on oxidic semiconductors, with special reference to applications of the principle of "controlled valency change." G. Busch, in association with J. Wieland and H. Zoller (Switzerland), dealt with the electronic properties of gray tin as a function of temperature and impurity content. H. K. Henisch, in association with Mlle. F. François, reported experimental and theoretical researches on the thermoelectric properties of selenium; and J. Volger (Netherlands) discussed some properties of mixed lanthanum and strontium manganites, such as the frequency and voltage dependence of resistivity, as well as galvanomagnetic and thermoelectric effects.

T. R. Scott (U.K.) opened the second day of the conference with a lecture on the engineering and chemical aspects of semiconductors and problems arising in the manufacture of metal rectifiers and crystal valves. C. A. Hogarth, in association with P. C. Banbury and H. A. Gebbie (U.K.), reported on the recently discovered properties of *p*-type lead sulphide as a transistor material. New phenomena of electronic conduction, with special reference to carrier injection and the direct measurement of drift velocities, were discussed by W. Shockley (U.S.A.). A lecture by K. Lark-Horovitz (U.S.A.) dealt with effects observed when semiconductors are bombarded by slow neutrons, heavy particles, and electrons, and with applications of these effects to the production of *p-n* barriers. W. H. Brattain (U.S.A.) introduced the subject of surface phenomena on semiconducting materials and referred particularly to the measurement of surface potential under illumination. P. R. Aigrain, in association with C. R. Dugas and W. Etzel (France), presented a new theory of crystal valves, and proposed explanations for certain observed anomalies in the bulk properties of germanium.

On Thursday, R. L. Sproull, in association with W. W. Tyler (U.S.A.), described a method of growing barium oxide crystals and reported results of electrical, optical, and photoelectric measurements over a wide range of temperatures and wavelengths. L. P. Smith (U.S.A.) discussed the motion of electrons and holes in single crystals of silver chloride, and R. W. Pohl (Germany) lectured on electron traps and hole conduction in alkali halide crystals containing *F*-centers under irradiation by visible light, x-rays and α-particles. A. E. Sandström (Sweden) presented a paper on the properties of selenium-blocking layer cells.

J. W. Mitchell, in association with E. W. J. Mitchell (U.K.), opened the proceedings on Friday with a description of a retarding potential method whereby the thermionic work function of germanium has been determined. P. H. Miller, Jr. (U.S.A.), lectured on the electrical and optical properties of zinc oxide, and showed that the experimental results are not satisfactorily accounted for by the simple band structure normally postulated. H. Krebs (Germany) discussed the conditions under which lattice defects are formed during the crystallization of selenium, tellurium, phosphorus, arsenic, antimony, and carbon. W. Shockley presented, in the authors' absence, a summarized paper by G. W. Castellan and F. Seitz (U.S.A.) on the energy states of impurities in silicon. Papers were also read by B. Vodar and N. Mostovetch (France) on the simulation of semiconductor properties by very thin metallic layers, and by T. J. Gray (U.K.) on the properties of semiconducting oxides. H. Y. Fan, in association with M. Becker (U.S.A.), dealt with the infrared optical properties of silicon and germanium as a function of temperature. During the closing session on Saturday, R. A. Smith and R. P. Chasmar, in association with E. H. Putley (U.K.), reported on their researches into the electrical and optical properties of certain sulphides, selenides, and tellurides.

The research laboratories of the Physics Department were open to visitors on two evenings, and a small exhibition of material and equipment contributed by private firms was also held. Conference members visited the Clarendon Laboratory, Oxford, by invitation of Lord Cherwell, F.R.S., and the research laboratories of Associated Electrical Industries, at Aldermaston, by invitation of T. E. Allibone, F.R.S.

A period for discussion was allocated to every paper presented at the conference. Many interesting and controversial issues were keenly debated, often in successful defiance of language difficulties and always in a spirit of good humor and tolerance. Apart from the scientific merit of the formal proceedings, it is thought that the general objectives of Unesco and of the International Union of Pure and Applied Physics were fully satisfied, inasmuch as the conference represented a modest though very real and sincere instance of international cooperation and understanding.

Inquiries concerning the proceedings should be addressed directly to Butterworths Scientific Publications, Ltd., 4,5,6, Bell Yard, London, W.C.2. The volume should appear toward the end of this year. In the meantime a small number of collected abstracts is still obtainable from the Conference Editor, Department of Physics, The University, Reading, Berks, England.

About People

George H. Coleman, dean of the Institute of Textile Technology, Charlottesville, Va., has been named professor of chemistry and director of the Friends of the Kresge-Hooker Library at Wayne University, Detroit. He assumed his new duties this month. Dr. Coleman will coordinate the library's services, and will also be responsible for the coordinating of the "Frontiers in Chemistry" lecture series, sponsored each year at Wayne by the Friends of the Kresge-Hooker Library and by the University's Chemistry Department.

D. Harold Copp, formerly assistant professor of physiology in the University of California School of Medicine, has been appointed head of the Department of Physiology in the new Medical School at the University of British Columbia, Vancouver.

Ed. F. Degering, formerly of Armour Research Foundation, has joined Miner Laboratories, where he will head a group working on problems of organic synthesis.

R. E. Dyer, director of the National Institutes of Health, will retire October 1, after 34 years with the U. S. Public Health Service. Dr. Dyer will become director of research at the Robert Winship Clinic, Emory University Medical School, Atlanta, Ga.

James E. McCormack has been appointed associate dean of the New York University Postgraduate Medical School, a unit of the New York University-Bellevue Medical Center. For the past two years Dr. McCormack has served as executive director of the Committee on Medical Science, Research and Development Board, Department of Defense.

G. Allen Mail, formerly research entomologist for the Boyle-Midway Division of American Home Products Corporation, has joined the staff of the Communicable Disease Center, U. S. Public Health Service, as entomologist (medical) and is stationed at Charleston, W. Va.

Ernst Mayr, curator of the Whitney-Rothschild Collections, American Museum of Natural History, New York City, has been elected an honorary member of the Royal Society of New Zealand.

Hans Neurath, of Duke University Medical School, has been appointed head of the Biochemistry Department at the University of Washington. Dr. Neurath has been professor of physical chemistry at Duke University since 1938.

Lothar W. Nordheim, professor of physics at Duke University, has joined the staff of the Los Alamos Scientific Laboratory for a one-year period. Dr. Nordheim has been granted a leave of absence from the university for this work.

Vincent E. Price, head of the Enzyme Unit, Biochemistry Section, National Cancer Institute, has accepted a one-year appointment to the University of Copenhagen Institute for Cytophysiology. The appointment will permit Dr. Price to study certain enzymes involved in the metabolism of nucleic acids, with Herman Kalcker, chief biochemist at the institute.

D. Rittenberg, associate professor of biochemistry, College of Physicians and Surgeons, Columbia University, will deliver the first lecture of the Rudolf Schoenheimer Memorial Lectureship of the American Society of European Chemists and Pharmacists, on October 5 at the New York Academy of Medicine, New York City. Dr. Rittenberg's subject will be "The Relation of Studies on the Metabolism of Cholesterol to Recent Developments of Biochemical Thought."

Visitors

Svend Thorkild Andersen, of Copenhagen, Denmark, arrived this month to spend a year as research associate with Stanley A. Cain, Pack Professor of Conservation, School of Natural Resources, University of Michigan. Dr. Andersen will work on an atlas of fossil and modern pollen of interest in paleontological investigations in northeastern North America and northwestern Europe.

Robert Betts and **W. R. Livingston,** of the Atomic Energy Project, Chalk River, Ontario; **Eugene Glueckauf,** head, Physical Chemistry Group, Atomic Energy Research Establishment, Harwell, England; and **Claude DeCroly,** Department of Metallurgy, University of Brussels, Belgium, were recent visitors at Ames Laboratory, Iowa State College Institute for Atomic Research.

Otto Frisch, chairman, Department of Nuclear Physics, Cavendish Laboratory, Cambridge University, England, lectured this month at Michelson Laboratory, U. S. Naval Ordnance Test Station, Inyokern, Calif.

Grants and Awards

The National Heart Institute has awarded Public Health Service grants totaling $230,773 for research on atherosclerosis to the following institutions: University of California at Berkeley—*John W. Gofman,* $81,000 for research in fundamental biochemical and biophysical factors

in the pathogenesis of atherosclerosis; Harvard School of Public Health, Boston—*Frederick J. Stare*, $43,702 for laboratory and cooperative field studies on Sf 10–20 molecules; Cleveland Clinic Research Division—*Irvine H. Page*, $57,903 for the study of lipoproteins and arterial disease; University of Pittsburgh—*Max A. Lauffer*, $48,168 for study of the characterization of blood lipoproteins and their relationship to atherosclerosis.

The 1950 Charles Mickle Fellowship, which is awarded annually by the University of Toronto to "the member of the medical profession who has done most during the preceding ten years to advance sound knowledge of a practical kind in medical art or science," has been awarded to Selman A. Waksman, Department of Microbiology, Rutgers University.

Donald W. Kerst, professor of physics at the University of Illinois, and Kenneth C. D. Hickman, chemical consultant for Arthur D. Little, Inc., have been awarded **John Price Wetherill Medals** by the Franklin Institute, Philadelphia. Dr. Kerst was cited for his contribution to the theory of the betatron, the application of the theory to the construction of the first practical machine, and his subsequent work in the field. Dr. Hickman will receive the medal in recognition of his research that made possible the production of vitamins A and E from raw materials once considered unusable. The institute's **Francis J. Clamer Medal** for achievement in the field of metallurgy has been awarded to Charles Sanborn Barrett, research professor at the Institute for the Study of Metals, University of Chicago. The medals will be presented on October 18, when other scientists also will be recognized for their achievements in various scientific fields.

The American Geographical Society has received a grant-in-aid from the **National Foundation for Infantile Paralysis** to assist in the printing and publication of a map of the world distribution of poliomyelitis. The map is the result of an 18-month survey that covered more than 100 health agencies throughout the world. It will be published on October 1 in the *Geographical Review* and is the first of more than a score of maps on world distribution of disease which will make up an atlas of diseases in process of development by the AGS.

Fellowships

The American Association for Thoracic Surgery has created a traveling fellowship for study of thoracic surgery or its related sciences, in the U. S. or Canada. The fellowship, with a stipend of approximately $1,000, will be an annual appointment. The Society of Thoracic Surgeons of Great Britain and Ireland has been invited to nominate the first fellow.

The Department of Zoology, University of California at Los Angeles, is accepting applications for the **Krichesky-Ponty Memorial Fellowship in Endocrinology,** recently donated as a memorial to the late Boris Krichesky, who was chairman of the department from 1945 until his death. The stipend, depending on the qualifications of the candidate, may be as high as $6,000 for 11 months, beginning as soon as convenient. Funds of $1,500 for an assistant and $1,000 for operating expenses are provided. Applications should be addressed to Theodore L. Jahn, Chairman, Department of Zoology.

Applications for 1951 grants-in-aid for cardiovascular research will be received by the **Life Insurance Medical Research Fund** until *November 15, 1950.* Support is available for physiological, biochemical, and other basic research which bears on cardiovascular problems, as well as for clinical investigation in this field. Preference is given to fundamental research. Applications for postdoctoral fellowships for training in research in 1951–52 will also be received until *November 1.* Preference will be given to candidates who wish to work in the broad field of cardiovascular function or disease and to candidates who wish to work in institutions other than those in which they have obtained most of their experience. An M.D., Ph.D., or the equivalent is required. The annual stipend varies between $3,000 and $4,000, with larger amounts in special cases. At least 15 postdoctoral fellowships will be available. A number of predoctoral fellowships for basic training in research will also be awarded. Further information and application blanks may be secured from Francis R. Dieuaide, Scientific Director, Life Insurance Medical Research Fund, 2 East 103rd St., New York 29.

Meetings and Elections

The American Oil Chemists Society will hold its fall meeting September 25–29 in San Francisco at the Sir Francis Drake. E. B. Kester and H. S. Olcott, of the Western Regional Research Laboratory, Albany, Calif., are general chairman and program chairman, respectively. There will be three days of technical papers, a reception on the evening of the 25th, and a visit to a copra mill on the 29th.

The quarterly meeting of the Board of Governors of the **National Speleological Society** will be held on October 7 at the Academy of Natural Sciences, Philadelphia, Pa.

The American Institute of Mining Engineers Industrial Minerals Division will meet October 17–20 at Norman, Okla. Twenty technical papers on industrial mineral commodities of the south-central and southwestern states will be presented. There will also be a special program dealing with titanium, and a two-day field trip. Robert H. Dott, state geologist of Oklahoma, is chief of the host organization.

A national noise abatement symposium, sponsored by the Armour Research Foundation and the National Noise Abatement Council, will be held October 20 at the Illinois Institute of Technology. Approximately 300 experts are expected to attend.

Edgar G. Rex, of the New Jersey Department of Agriculture, was

elected president of the **Northeastern Division of the American Phytopathological Society** at the division's recent meeting at the Connecticut Agricultural Experiment Station. Other officers elected were James M. Hamilton, New York State Agricultural Experiment Station at Geneva, vice president; S. G. Younkin, Campbell Soup Research Department, Riverton, N. J., secretary-treasurer; and L. M. Black, Brooklyn Botanic Garden, councilor.

Deaths

James B. Murphy, cancer specialist, died August 24 in Bar Harbor, Maine, after a brief illness. He was 66 years of age. Dr. Murphy retired as head of the Laboratory of Cancer Research of the Rockefeller Institute in July. He had been associated with the institute since 1910.

Newton L. Pierce, associate professor of astronomy at Princeton University, died August 8, after a brief illness, at the University of Pennsylvania Graduate Hospital in Philadelphia. He was 45 years old. Dr. Pierce was assistant director of the Princeton Observatory and was well known for his study of eclipsing variable stars.

George Clinton Price, 90, professor emeritus of zoology at Stanford University, died August 11, in Palo Alto, Calif., after a long illness. Dr. Price was a member of the Stanford faculty for 28 years until his retirement in 1925.

Clara Stoltenberg, professor emeritus of neurology at Stanford University, died February 2 at her home on the university campus. She was 88. Miss Stoltenberg was an active member of the faculty from 1897 until her retirement in 1930.

Charles H. Warren, 73, dean emeritus of the Sheffield Scientific School at Yale University, died August 16 in Torrington, Conn. Dr. Warren was a staff member of the Massachusetts Institute of Technology from 1900 to 1922, when he became dean of Sheffield and chairman of the Geology Department at Yale. In 1938 he became professor of mineralogy and was widely known for his writings in that field.

The Institute for Physical Medicine and Rehabilitation, 325 East 38th St., New York City, will conduct a workshop in rehabilitation September 25–October 20. Instruction will be provided by staff members of the institute, the New York University School of Education, and other specialists. The course includes medical aspects of rehabilitation, psychosocial aspects, clinical study and observation, case study and evaluation, counseling tools and techniques, vocational training, and placement tools and techniques.

The National Cancer Institute of the U. S. Public Health Service has published in booklet form *The Challenge of Cancer*, by Lester Grant. Mr. Grant won the 1949 AAAS-George Westinghouse Newspaper Science Writing Award for the 15 articles that form the basis of the book and that originally appeared in the New York *Herald Tribune*. The articles have been revised, and 4 new ones have been added by the author in collaboration with staff members of the National Cancer Institute. The book is available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 55 cents per copy.

A new technique for drying biological specimens selected for examination and analysis under the electron microscope has been developed at the Johnson Foundation for Medical Physics, under the direction of Thomas F. Anderson, assistant professor of biophysics, University of Pennsylvania School of Medicine. The new method makes it possible to retain the three-dimensional aspects of biological specimens without the change in structural form that occurs in the usual dehydration process. In ordinary drying the receding surface of water tends to flatten most specimens. The new technique replaces the water with a liquid that has a low surface tension at room temperature, such as carbon dioxide under high pressure, which becomes a gas when the temperature is raised. After the gas is allowed to escape the specimens stand out in bold relief.

The Philadelphia Section of the American Chemical Society is sponsoring two special noncredit evening courses to be given at the Philadelphia College of Pharmacy and Science, 43rd and Kingsessing Ave., Philadelphia. The course in bacteriology for chemists, to begin October 9, will be presented by D. J. O'Kane, assistant professor of microbiology, University of Pennsylvania. The course in advances in chemical analysis, starting October 10, will consist of ten lectures by well-known authorities. Further information concerning the courses may be obtained from Dr. R. E. Vener, Drexel Institute of Technology, Philadelphia, Pa.

The Division of Medical Sciences of the National Research Council has arranged a **symposium on burns** to be held in the National Academy of Sciences Building, Washington, D. C., November 2–4. Every effort has been made to include in the five sessions of this symposium subjects of most immediate significance in the vital problem of thermal injury by atomic radiation. The sessions are open to persons having a professional interest in burn research, or responsibility for medical preparedness in either military or civil defense. Advance registration is not required, but those planning to attend are urged to notify The Secretary, Division of Medical Sciences, 2101 Constitution Avenue, N.W., Washington, D. C.

The deadline for mailing entries in the **Fifth AAAS-George Westinghouse Science Writing Awards** is midnight, October 8, 1950. Readers of SCIENCE are urged to submit articles or to nominate entries before that date. Write or wire for information and entry blanks to Howard A. Meyerhoff, Chairman, Managing Committee, 1515 Massachusetts Ave., N.W., Washington, D. C.

What GENERAL ELECTRIC People Are Saying

T. R. HAND
Apparatus Department
C. J. FALK
General Engineering & Consulting Laboratory

QUALITY CONTROL: In industrial manufacturing, every production line will produce some rejects. To keep those rejects within economic limits, a technique known as scientific quality control has been developed.

Scientific quality control employs control charts which are based on mathematical probabilities. With knowledge of past production history, it is possible to predict with a known degree of risk whether present production conditions are producing too high a reject rate. The method has often resulted in reducing reject losses in a manufacturing process from 30 to 50 percent . . .

With scientific quality control, each inspector on a production line makes a mark on a tally sheet every time he rejects a unit. A separate tally sheet is provided for each test or characteristic which he is checking. At the end of a shift or at the end of the day, these tally sheets are collected from all of the inspectors and tabulated by the quality-control engineers. Each test is then individually analyzed to see whether that particular test is falling within the predetermined economic limits. If it is found that too many rejects have occurred and the upper control limit is exceeded, then the quality-control engineer informs the production supervisor that abnormal trouble is present and corrective action is indicated. In the meantime, rejects are still being produced . . .

Quality-control engineers at General Electric's Erie Works . . . realized how much more effective statistical quality control could be if the information presented by control charts was immediately available . . . The problem presented . . . was the development of a computer which would give instantaneous quality control.

The computer should count the rejects and total production on a production line and should analyze these counts immediately . . . The Quality Control Indicator is the solution to this problem . . .

At General Electric's Erie Works . . . a 60-percent reduction in rejects followed installation of the quality control indicator on a compressor assembly line. On this line, monitoring only five tests, more than $10,000 was saved the first year by reduction of scrap and rework expense. Greater efficiency also resulted, since a production supervisor could more easily direct his efforts where they were needed. Much closer quality control was achieved . . . and the customary rise in rejects during the vacation period did not occur after the quality control indicators were installed . . .

Quality-control engineers using the computer have called it the biggest step forward in scientific quality control since the beginning of quality control itself.

General Electric Review
July, 1950

☆

W. R. G. BAKER
Vice President

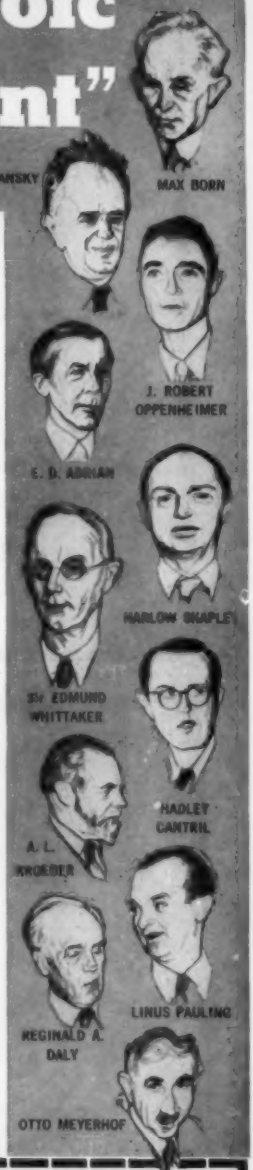
COLOR TELEVISION: A new system of color television, which General Electric has submitted to the FCC, provides a method of transmitting color picture information within a frequency band no wider than that used in present-day black and white transmission and could be used with either the three-tube or the single picture tube systems advocated by other companies at the recent FCC color hearings.

This new system is called "frequency interlace." Under ordinary conditions, announcement would not be made until field tests were completed, but since the FCC is currently studying other systems, it was necessary to reveal now that the system is being tested and that these tests to date indicate technical soundness.

Among the advantages over other known systems, frequency interlace would permit relatively low-cost TV receivers, reliable in operation, easy to adjust and maintain, and simple in construction. The system is inherently compatible with present black and white standards; it would permit color broadcasts to be received in black and white on present-day receivers or black and white broadcasts to be received on color receivers incorporating the new system. It would also permit reception free of twinkle, crawl, or flicker.

Syracuse, New York
July 27, 1950

"An Account of Heroic Human Achievement"



Presenting a symposium by great scientists on

THE AGE OF SCIENCE: 1900-1950

• To the community of U. S. citizens who share a responsible concern in the advance and use of scientific knowledge, it is the privilege of the Editors of the new SCIENTIFIC AMERICAN to announce the publication of an extraordinary issue of this magazine.

Under the title of the Age of Science: 1900-1950, the September 1950 issue of SCIENTIFIC AMERICAN is entirely devoted to a symposium on the century's historic advances in scientific knowledge, written by a group of the world's foremost scientists.

In his introduction to the symposium, J. Robert Oppenheimer says:

"The 10 reports in this issue do indeed attest that science says things that no one knew before in a way we can all understand. They are reports, each written by a man eminent in his science, of what has happened in that science during the last half-century. They are diverse in style and in substance, reflecting the great diversity of the several sciences and the healthy and heartening diversity of the authors. Yet they all tell heroic stories. They all tell of a period of unparalleled advance of understanding, of new experience, new insight and new mastery. Indeed, for some of the sciences—biochemistry, physics, genetics—the half-century now closing has been a time of splendor: of great men and great discoveries, of a real revolution in our knowledge of the world. For all the sciences it has been a time of extraordinary vitality and progress, extending and enriching what we know about the world and for every question answered unearthing a host of new questions."

SCIENTIFIC AMERICAN

24 W. 40th St., New York 18

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CHARGES and REQUIREMENTS for "PERSONNEL PLACEMENT" Ads

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POSITIONS WANTED

Bacteriologist: B.S. 23, Penn State graduate. Desires experience in industrial bacteriology. Box 299, SCIENCE. X

Bacteriologist: M.S., woman, 32. Two years teaching as graduate assistant. Qualifications include research and diagnostic bacteriology. Prefer academic or research position. Box 300, SCIENCE. X

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POSITIONS OPEN

Bacteriologist; B.S., Experienced research assistant for studies on chemotherapy of experimental tuberculosis. American Cyanamid Company, Stamford, Connecticut. 9/22

Biochemist: Ph.D., Young man or woman as collaborator in research project, experimental tuberculosis involving enzymology and nucleic acids. Philadelphia laboratory. Box 303, SCIENCE. X

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Personnel Placement

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Technical Development Chemist: Ethical pharmaceutical house in East wants technical development chemist with following qualifications: M.S. or Ph.D. in Pharmacy with Chemical Engineering minors. 8 years experience in pharmaceutical engineering or development. 2 years experience in industrial cosmetic development desirable. Must have supervisory experience. Male, under 40, preferably married. Box 304, SCIENCE. 9/29

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Single insertion	$16.00 per inch
7 times in 1 year	14.50 per inch
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For ***display*** advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

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For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

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which you have for sale.
Complete libraries; sets and runs; and single titles are wanted.
Also please send us your want lists.
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We need Complete Sets, Runs, Volumes and Single numbers.
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The Market Place

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SUPPLIES AND EQUIPMENT

REGISTER NOW

for the Cleveland Meeting of the AAAS

AVOID CONGESTION AND DELAY
GET YOUR GENERAL PROGRAM –
BY FIRST CLASS MAIL – EARLY IN DECEMBER

Registration in *advance* of arrival at the 117th Annual Meeting of the AAAS in the downtown hotels of Cleveland, December 26–30, 1950, has so many advantages that we wonder why almost *everyone* doesn't take this simple step. For instance:

1. You avoid congestion and delay at the Registration Desks in busy foyers at time of arrival. All indications point to a large attendance since all of the Association's seventeen sections and subsections, and more than forty societies, will have sessions with excellent programs and there will be a number of important symposia.
2. You receive the General Program early in December in ample time, unhurriedly to decide among the events and the sessions that you wish to attend.
3. Your name and hotel address will be in the enlarged Visible Directory the first hour of the first day of the meetings, since it will be posted in Washington as soon as processed.
4. Advance Registrants will have the same privileges of receiving a map and directory of points of interest of Cleveland, literature, radio broadcast tickets, etc. At the convenience of Advance Registrants, these will be distributed from the Main Registration in the Public Auditorium—the location of the Annual Science Exposition, the Visible Directory, and the Science Theatre. Admission to the splendid series of latest scientific films will be free to all Registrants.

At the 1949 Meeting, the Council of the AAAS voted overwhelmingly to continue Advance Registration. To insure its prompt receipt, the General Program will be sent by *first class mail* December 1–4, 1950—which is also the *closing date* for Advance Registration.

- - - - - - - - THIS IS YOUR ADVANCE REGISTRATION COUPON - - - - - - - -

1. Advance Registration Fee (the extra quarter covers part of the first class postage) enclosed: (check one)
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3. ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....
4. OFFICE OR HOME ADDRESS ..... (For receipt of Program and Badge)
5. YOUR FIELD OF INTEREST .....
6. CONVENTION ADDRESS ..... (If not known now may be added later)
7. DATE OF ARRIVAL ..... DATE OF DEPARTURE .....

Please mail this Coupon and your check or money order for the fee, $2.25 or $3.25, to
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1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Accurate Radioassays at LOWEST COST

The new low price of the Tracerlab "64" Scaler makes it possible to do accurate radioassay work even on a very limited budget. This highly reliable instrument indicates the number of counts arriving during a length of time controlled manually by the operator. The result appears on the dial of the built-in Wizard register and on the neon interpolating lights.

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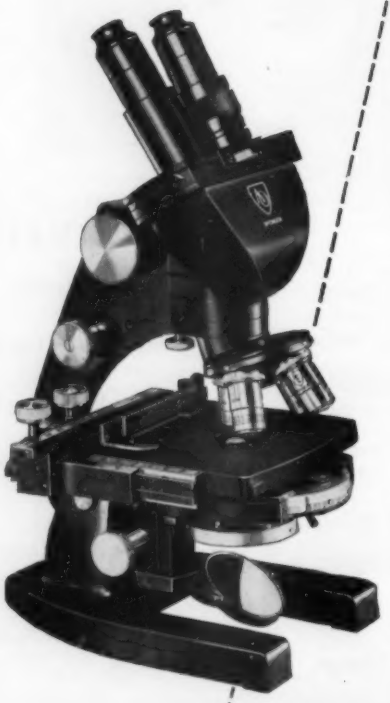
This new series of instruments combines the advantages of "Phase" with the recent mechanical advancements in AO Spencer Microscopes. Write for free booklet to Dept. J4.



★ **RESPONSIVE FINE ADJUSTMENT**
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Substage and coarse focusing tension instantly set to suit your touch.

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